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Project Report
ATC-186

Summary of Triple Doppler Data Orlando 1991

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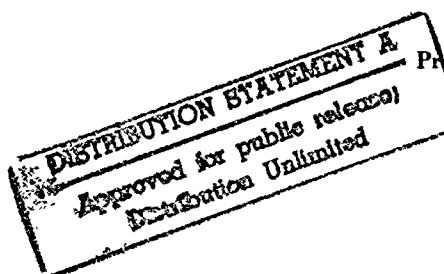


7 April 1992

Lincoln Laboratory

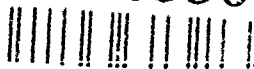
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16. Abstract Under Federal Aviation Administration (FAA) sponsorship, Lincoln Laboratory conducted an aviation weather hazard measurement and operational demonstration program during the summer of 1991 near the Orlando International Airport. Three Doppler radars were sited in a triangle around the airport, allowing triple Doppler coverage of thunderstorms and microbursts occurring there. This report contains a summary of all the microburst-producing thunderstorms that occurred within the triple Doppler region that were scanned in a coordinated fashion, during the months of June, July, August, and September 1991. Statistics on the microburst events are presented to give an overall picture of the available data for use in analysis. The bulk of the report consists of detailed information about each triple Doppler day, including the time, location, and strength of microbursts within the triple Doppler period as well as the availability of data from supporting sensors, including the ASR-9-WSP Doppler radar, radiosondes, LLWAS, Mesonet, AWOS, instrumented aircraft, ACARS, interferometer, and corona points.			
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ABSTRACT

Under Federal Aviation Administration (FAA) sponsorship, Lincoln Laboratory conducted an aviation weather hazard measurement and operational demonstration program during the summer of 1991 near the Orlando International Airport. Three Doppler radars were sited in a triangle around the airport, allowing triple Doppler coverage of thunderstorms and microbursts occurring there. This report contains a summary of all of the microburst producing thunderstorms that occurred within the triple Doppler region that were scanned in a coordinated fashion, during the months of June, July, August, and September, 1991. Statistics on the microburst events are presented to give an overall picture of the available data for use in analysis. The bulk of the report consists of detailed information about each triple Doppler day, including the time, location, and strength of microbursts within the triple Doppler period as well as the availability of data from supporting sensors including the ASR-9-WSP Doppler radar, radiosondes, LLWAS, Mesonet, AWOS, instrumented aircraft, ACARS, interferometer, and corona points.

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1. INTRODUCTION

The Federal Aviation Administration (FAA) Terminal Doppler Weather Radar (TDWR) and Airport Surveillance Radar (ASR-9) program offices sponsored an aviation weather hazard measurement and operational demonstration program during the summer of 1991 near the Orlando International Airport, principally to test and refine techniques for the automatic detection of low-altitude wind shear phenomena [1, 2]. The FAA Integrated Terminal Weather System (ITWS) program contributed to the measurement effort to develop a data-base of "true" three dimensional winds in thunderstorms. By integrating data from several operational terminal area and aircraft sensors and by utilizing sophisticated computational techniques for processing single Doppler weather radar data, ITWS will be able to provide detailed three dimensional winds in the terminal area. The FAA Terminal Area Surveillance System (TASS) program also contributed to the measurement effort to develop a data-base of thunderstorm phenomena using rapid update scans and full volume coverage. The TASS program is intended to develop aircraft and weather surveillance systems for the 21st century; electronically scanned phased-array radars are under consideration as a means for providing rapid update data on fast-evolving thunderstorms.

Three Doppler weather radars were sited in a triangular configuration, each located about 6 mi from the Orlando airport, to provide full volume coverage of thunderstorms and microbursts occurring at the airport. With three Doppler radars, the full three dimensional wind field in a storm can be unambiguously recovered [3, 4, 5]. The radars, shown in Fig. 1, included the Terminal Doppler Weather Radar C-band testbed (TDWR), the University of North Dakota C-band Doppler radar (UND), and the Massachusetts Institute of Technology C-band Doppler radar (MIT).

The region in which three dimensional winds can accurately be synthesized at all altitudes lies within the triangle defined by the radar locations (Fig. 2). Each radar scanned a sector 80° – 120° wide over this "triple Doppler region". The elevation angle scan strategy for the three radars during June and July was dictated by the TDWR operational hazardous weather scan. The volume update rate was 2.5 min, and the beam elevation angles that were scanned are illustrated in Fig. 3. The TDWR scan emphasizes measurements of low altitude phenomena, so the coverage is more dense below 5 km. During August and September, a 3 min volume update rate was employed with more evenly spaced beams. This is illustrated in Fig. 4. If the storms developed before they entered the triple Doppler region, the MIT radar was often able to provide rapid update rate RHI scans to document the thunderstorm evolution.

The supporting sensor data available in Orlando included data from a Lincoln operated Airport Surveillance Radar (ASR-9) with the Wind Shear Processor (WSP) add-on, special thermodynamic soundings, occasional instrumented aircraft data, LLWAS (Low Level Wind Shear Alert System) and Mesonet data, Automated Weather Observing System (AWOS) data, lightning data from the SAFIR interferometer system deployed by the French government laboratory ONERA, and cloud electrical activity data from an array of corona points. In addition, the NOAA Forecast Systems Laboratory (FSL) recorded and supplied Lincoln Laboratory with ACARS (Aircraft Communications Addressing and Reporting Service) data from commercial jets throughout the country via the ARINC (Aeronautical Radio, Inc.) Company.

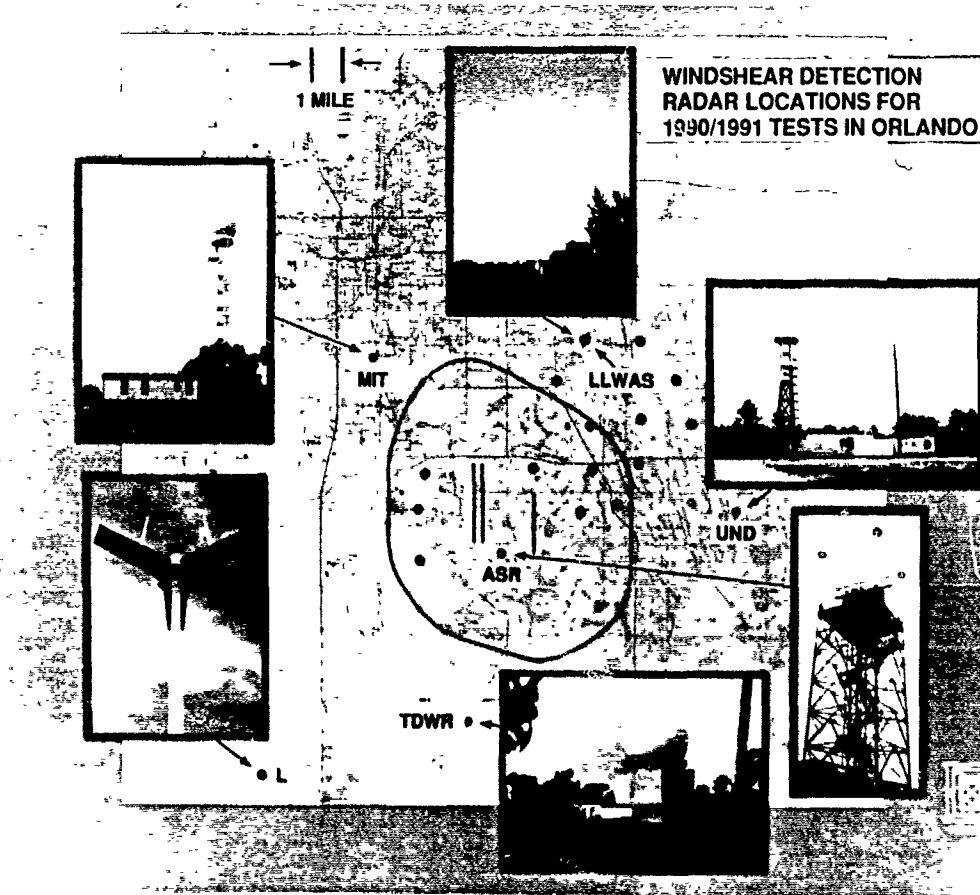


Figure 1. Map showing the 1991 TDWR, UND, and MIT C-band Doppler radar locations in Orlando. The Orlando International airport runways are shown as 3 north-south oriented lines near the center of the map, and the region of TDWR coverage is shown by the roughly circular black outline around the airport. Lincoln Laboratory also operated a wind shear processor add-on to the FAA Airport Surveillance Radar (ASR), and a network of automatic weather stations shown as black spots labelled LLWAS (for Low Level Wind Shear Alert System; data from the FAA LLWAS around the airport was recorded but those stations are not shown on this map). The SAFIR interferometer system for measuring lightning is shown in the lower left corner (L).

The Lincoln operated ASR-9 scanned a full 360° once every 4.8 s with its dual fan-beam antenna. This radar provided a measure of thunderstorm reflectivity that is proportional to vertically integrated liquid water content and, by using sophisticated signal processing techniques [6, 7], the Doppler velocity at low altitude as well. The radiosondes, launched by University of Massachusetts at Lowell personnel at the UND radar site, measured winds (via cross-chain LORAN tracking), temperature, and dew point as a function of pressure

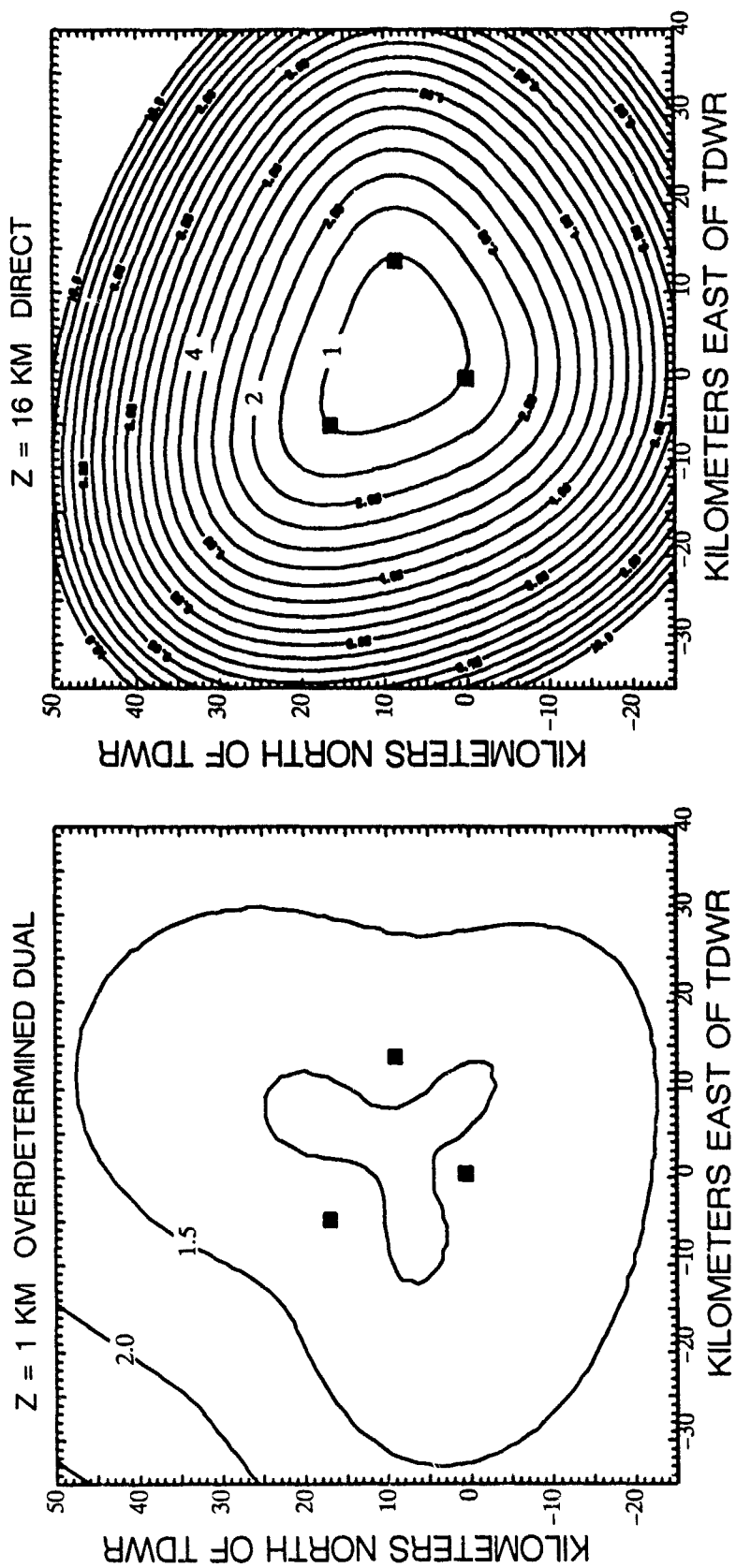


Figure 2. Contours of vertical velocity error (m/s) at 1 km AGL (left) and 16 km AGL (right) using the most favorable wind synthesis method in each case. The errors are calculated assuming that each radar has an inherent error of 1 m/s in its Doppler measurement. The common region of low error coverage lies within the triangle defined by the three Doppler radars (TDWR, MIT, and UND).

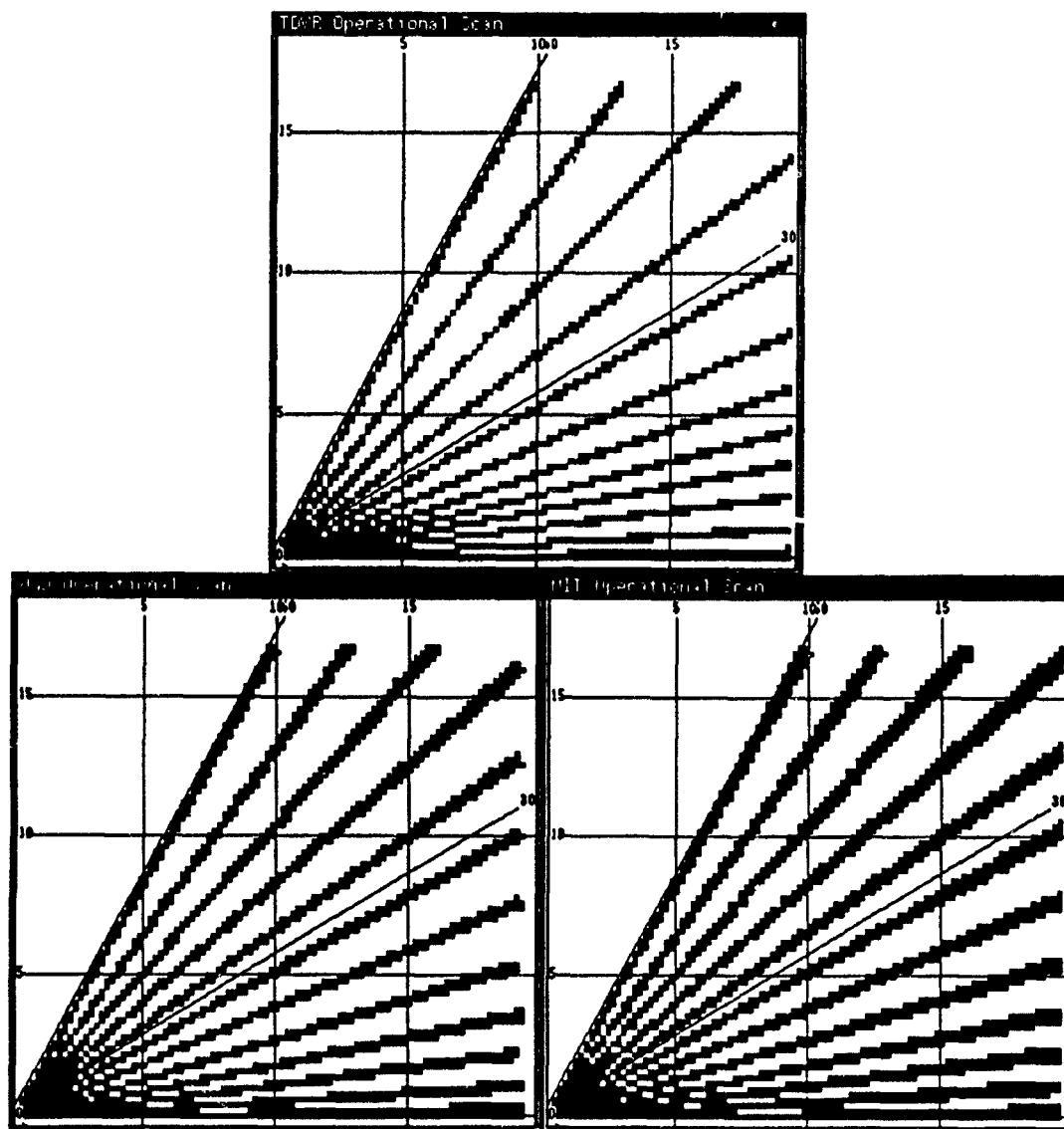


Figure 3. Illustration of 2.5 min volume update rate TDWR scan. The TDWR testbed radar is shown on top with a 0.5° beamwidth, UND is shown in the lower left with a 1° beamwidth, and MIT is shown in the lower right with a 1.4° beamwidth. In each frame, the radar is located in the lower left corner and the dark "beams" represent the 3dB radar coverage. The scale is indicated by the overlying grid with labels at 5, 10, and 15 km. Lines representing the 30° and 60° elevation angles are also shown.

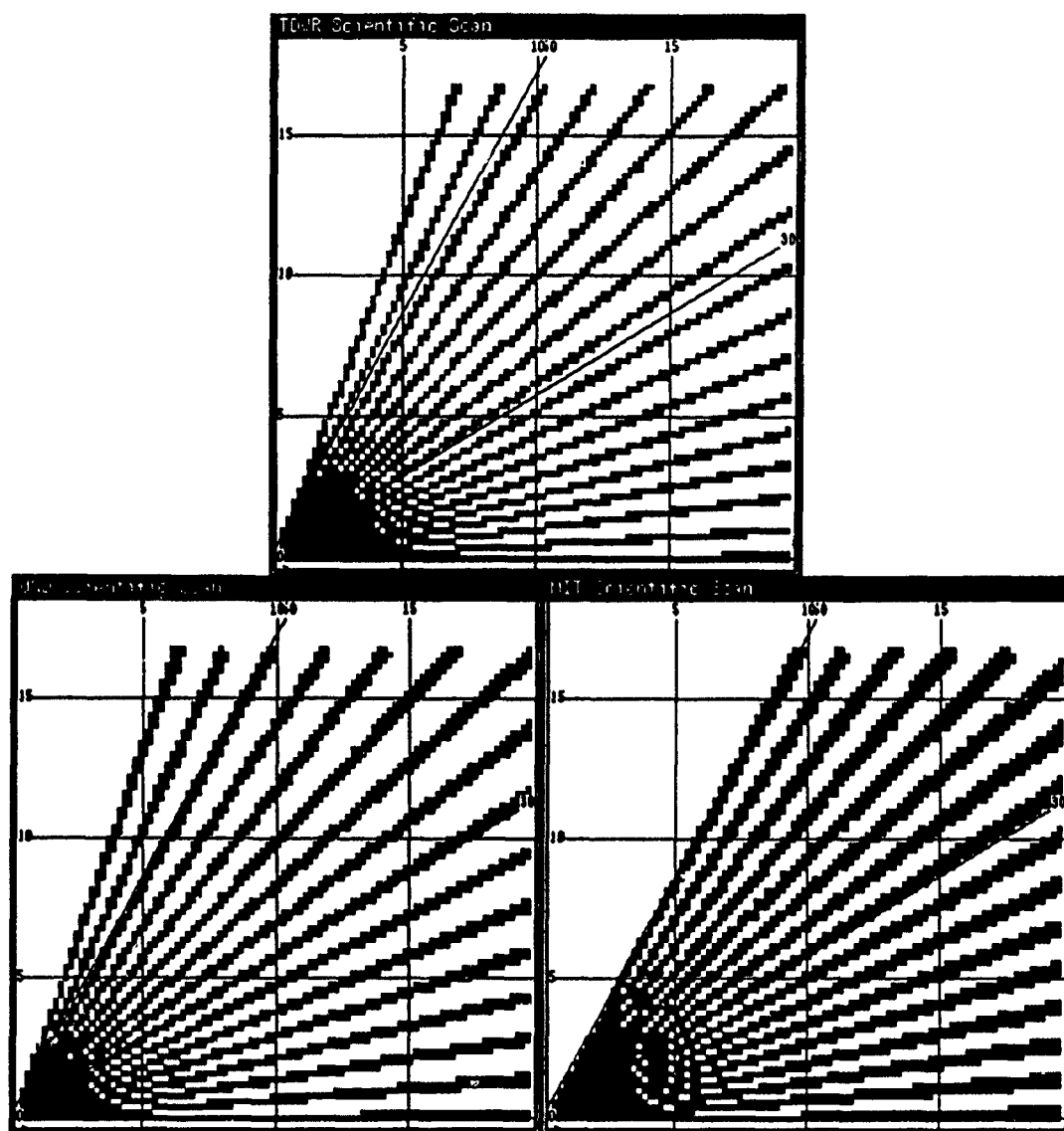


Figure 4. As in Fig. 3, but for the 3 min volume update "Scientific" scan.

altitude within the atmosphere. The soundings were launched at 3 hour intervals and took approximately 1 hour to complete. One instrumented aircraft was a B737 flown by NASA Langley Research Center at Orlando from June 10th through 20th. The aircraft was instrumented with reactive (accelerometer-based) and forward-looking wind shear detection systems. The forward-looking systems included both passive infrared and Doppler radar systems. The Westinghouse BAC1-11 aircraft was also on site during August, but no microburst penetrations with triple Doppler coverage were performed. The LLWAS stations operated by the FAA measured wind speed and direction every 10 s with sensors mounted on poles of varying height according to the degree of sheltering at each site. To supplement the LLWAS measurements, Lincoln Laboratory operated a 15 station Mesonet, which measured wind speed and direction every 10 s with sensors mounted on 100' towers, and temperature and relative humidity every minute with sensors mounted approximately 6' above ground level in a vane aspirator. A map of the LLWAS and Mesonet stations is shown in Fig. 5. Data were also recorded from the FAA AWOS system at the Kissimmee airport, west of the TDWR radar site. A personal computer belonging to NCAR was located on-site to record the data. (Since NCAR was participating in the CaPE scientific experiment at Cape Canaveral during July and August, they also wanted to collect available supporting data.) The AWOS measured wind speed and direction, temperature, dew point, precipitation, pressure (and altimeter setting), ceiling/sky condition, and visibility every minute. The SAFIR interferometer consisted of two remote antenna systems that were used to detect and locate VHF noise from lightning [8], with a time resolution of 100 μ s. A network of 13 corona points was used to monitor the polarity of the surface electric field and lightning activity within 10-15 km of the sensors, with a sampling rate of 1 Hz. The corona point station locations are shown in Fig. 6. Since different corona point sensors could be physically located on the same corona point station (e.g., when a malfunctioning sensor had to be replaced), Appendix A lists each corona point station, its associated sensors, and the dates of the association. Finally, ACARS data were recorded by NOAA FSL in Boulder and supplied to Lincoln for every period in which triple Doppler measurements were made. These data include wind speed and direction from the onboard INS, ambient temperature, and aircraft location (latitude, longitude, and altitude).

This report contains a summary of all of the thunderstorms that occurred within the triple Doppler region and that were scanned in a coordinated fashion during the months of June, July, August, and September, 1991. Statistics on the microburst events are presented in the following chapter, and individual information sheets for each triple Doppler day are presented in Chapter 3. Chapter 2 is designed to present an overall picture of the available data for use in analysis; it contains charts describing the location, wind speed distribution, and frequency of events over the entire period. Chapter 3 gives detailed information about each triple Doppler day (some days have more than one triple Doppler period), including the time, location, and strength of microburst events within the triple Doppler period as well as the availability of data from the supporting sensors including ASR-9 radar, aircraft, radiosondes, LLWAS, Mesonet, AWOS, interferometer, corona points, and ACARS. Chapter 4 gives a brief summary and information for readers who wish to request data described in this report.

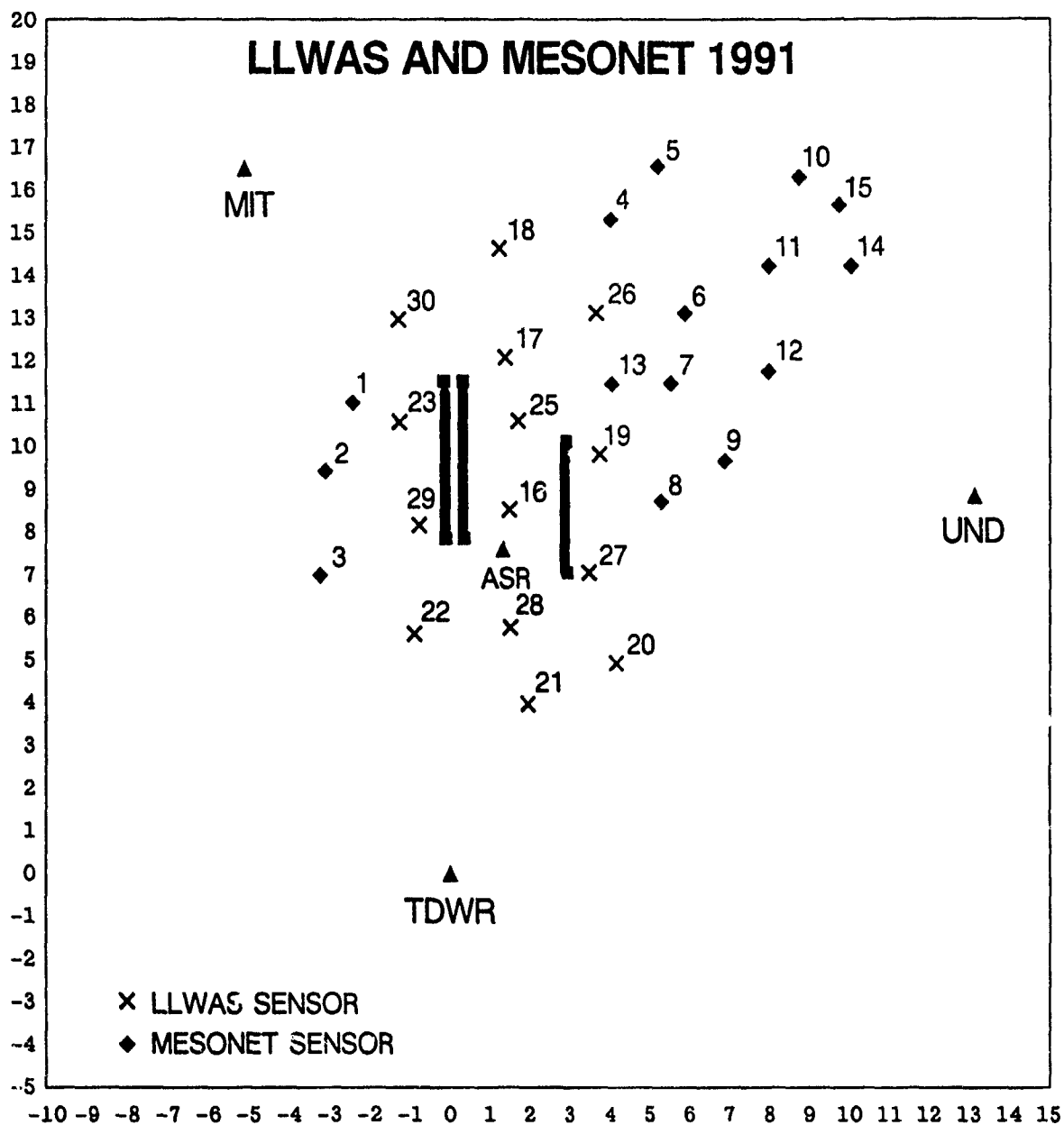


Figure 5. Locations of the Lincoln Laboratory Mesonet stations (diamonds) and the FAA LLWAS stations (Xs) around the Orlando International Airport in 1991. Each LLWAS and Mesonet station is given an identifying number, shown next to the station location mark. The airport runways are shown as three thick black lines in the center of the chart, and the TDWR, MIT, and UND radar locations are shown as triangles.

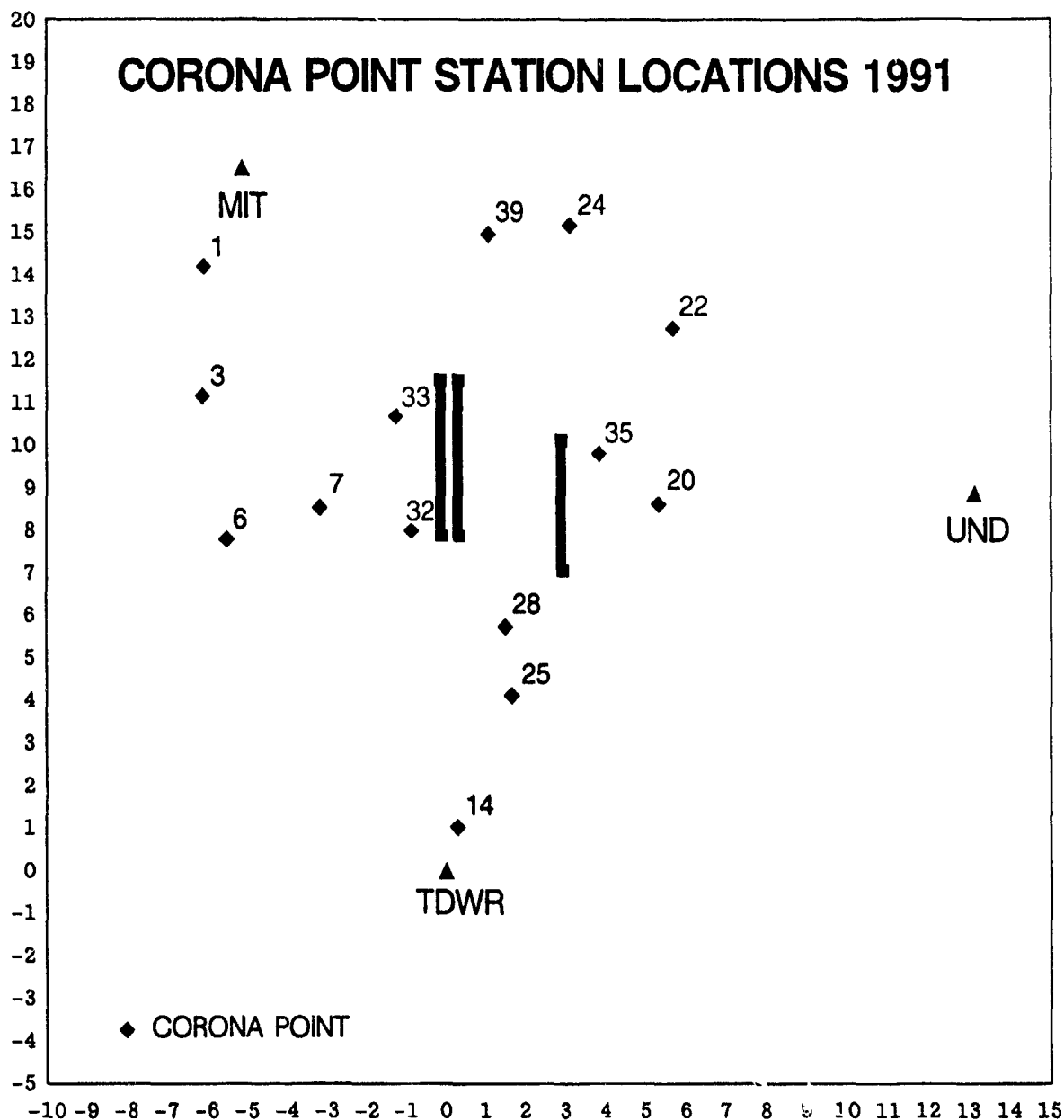


Figure 6. As in Fig. 5, except 1991 corona point station locations (diamonds) are shown. Each corona point station is given an identifying number, shown next to the station location mark.

2. DATA SUMMARY

This chapter describes the triple Doppler data set in general. Figure 7 summarizes the number of microburst events per day during the entire data collection period. A total of 60 events were observed over the summer. Events for which instrumented aircraft data are available are indicated by dark shading. The MIT radar was struck by lightning on June 26, and did not return to service until July 24. Two or more events were recorded on most triple Doppler days because new storms often formed adjacent to old ones, and the storm systems themselves were generally slowly translating.

Figure 8 shows the distribution of maximum outflow differential wind speed in the triple Doppler microbursts, as determined from the TDWR Doppler radar only. Microbursts of widely varying strengths were recorded, ranging from the operational threshold of 10 m/s up to 45 m/s (August 9, 1991). The August 9 event ranks as one of the most severe microbursts ever recorded with the TDWR testbed radar.

Figures 9 through 12 show the monthly locations, respectively, of triple Doppler microbursts. The markers are placed where the microburst outflow reached its maximum. When the marker is shaded, it indicates that the complete life cycle of the microburst was observed with triple Doppler coverage. In this report, the region of triple Doppler coverage is defined as the area within the triangle created by connecting the three radars. Complete life cycle includes the first echo growth, but in many cases mature storms were already present and the new "first echo" represented the continued development of a discretely propagating multicell storm. Complete life cycle coverage is available for 41 events, including the 45 m/s microburst on August 9. Very few triple Doppler events were recorded in July only because the MIT radar was down (Fig. 10); the daily thunderstorm frequency was at its peak during this period. The thunderstorm frequency died off rapidly in September, explaining the small number of events shown in Fig. 12.

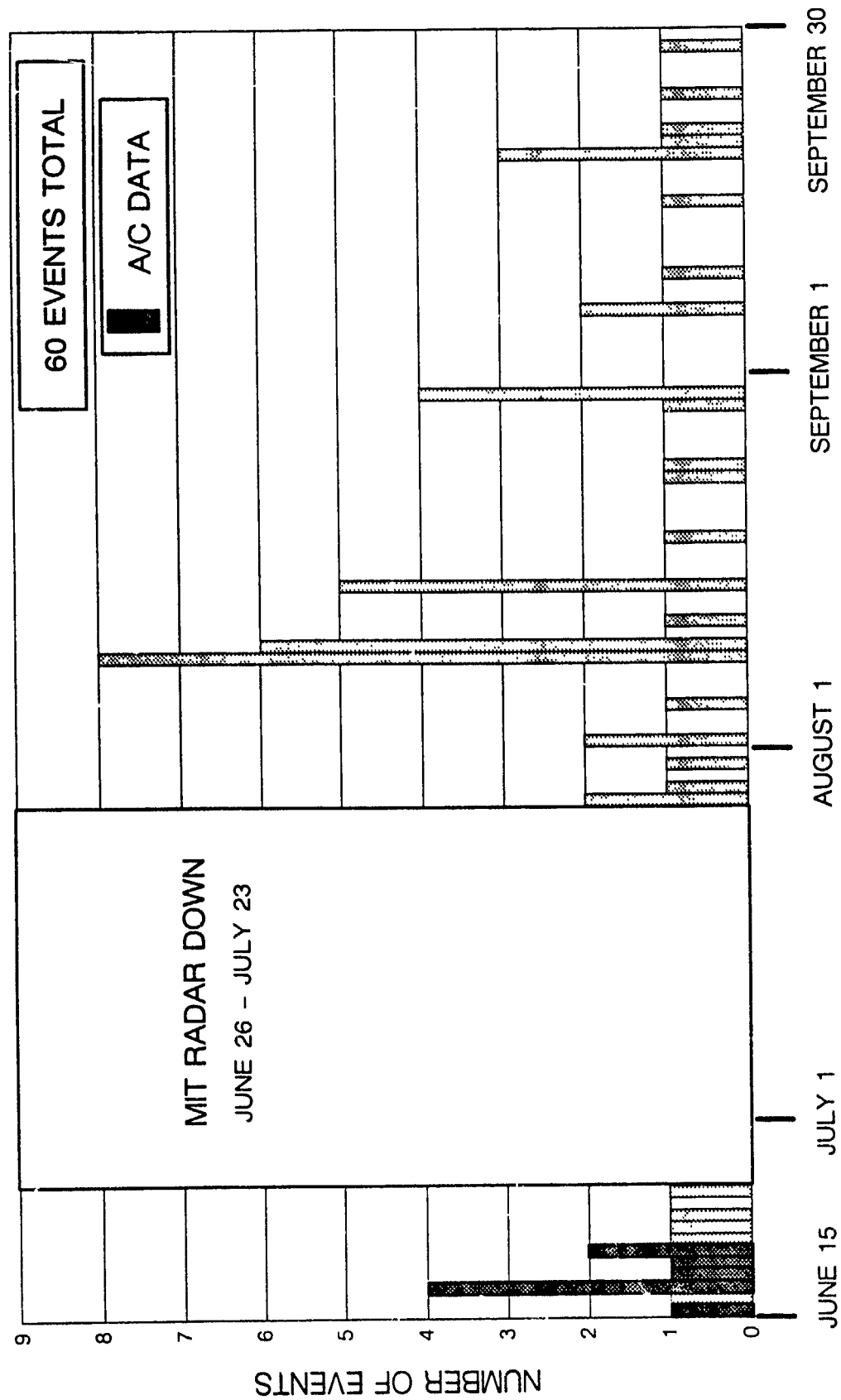


Figure 7. Histogram of triple Doppler microburst events in Orlando, 1991. A total of 60 events were observed.

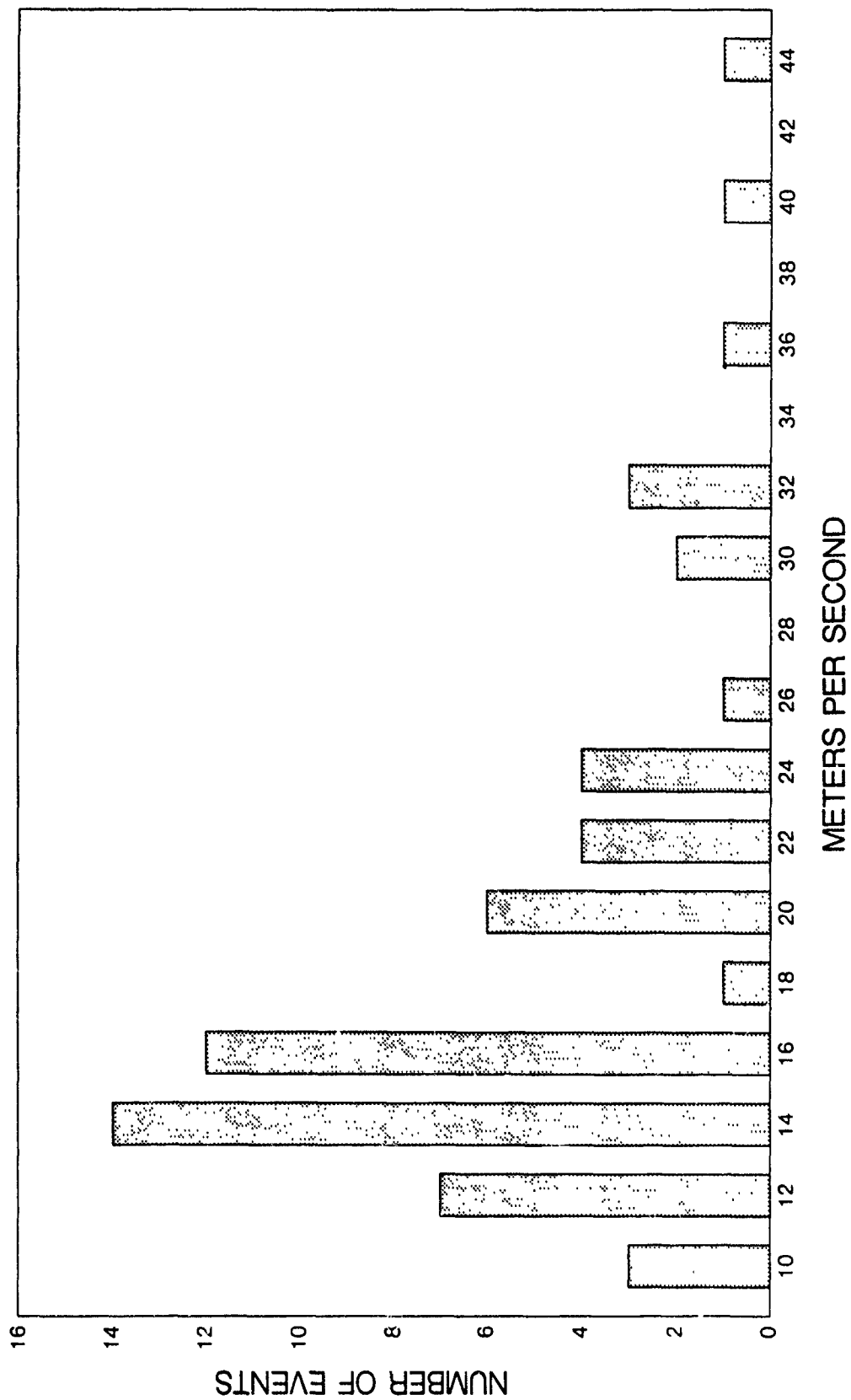


Figure 8. Histogram of microburst maximum differential wind speed for all triple Doppler microburst events as determined from TDWR Doppler signature.

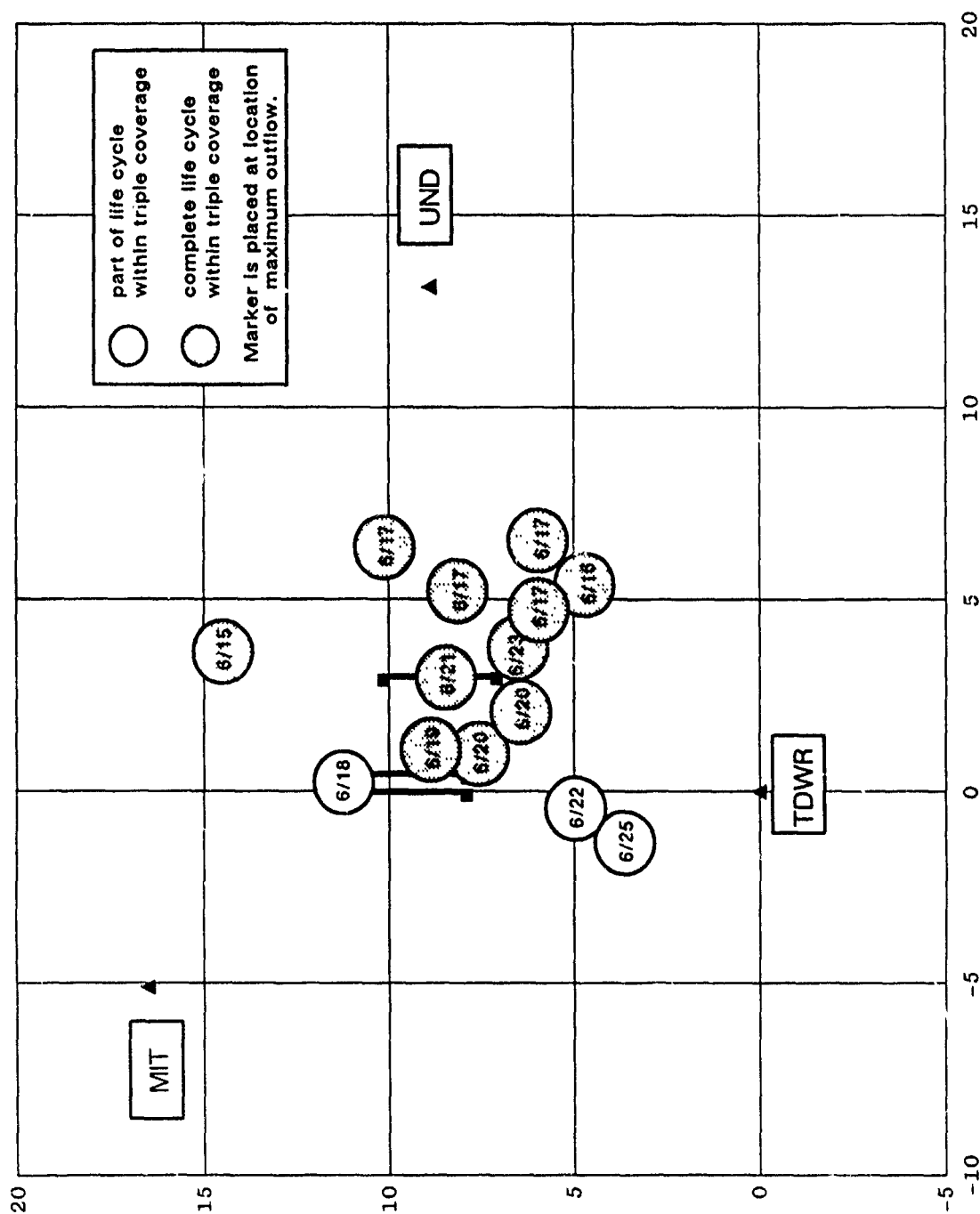


Figure 9. Location of triple Doppler microburst events during June, 1991.

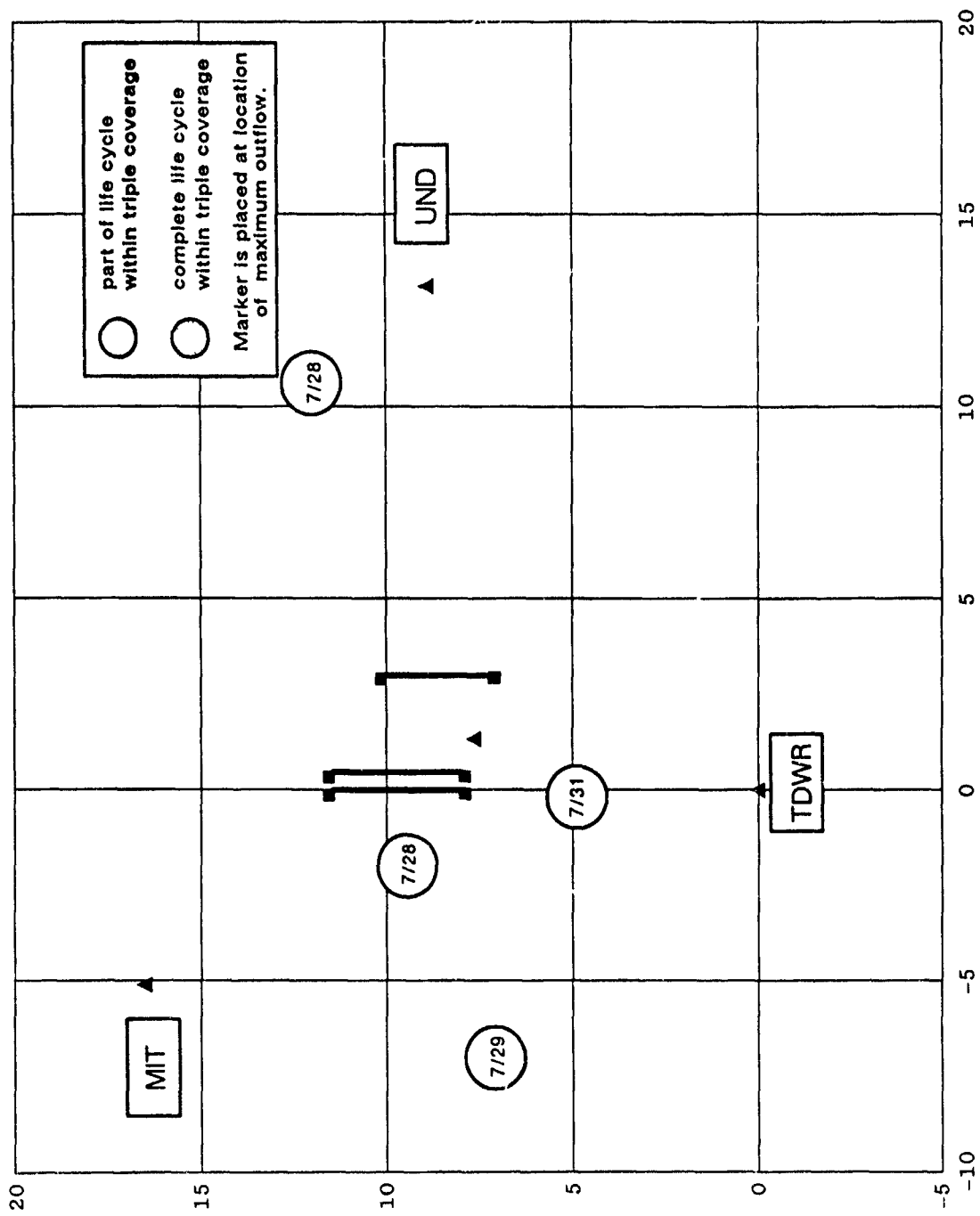


Figure 10. Location of triple Doppler microburst events during July, 1991.

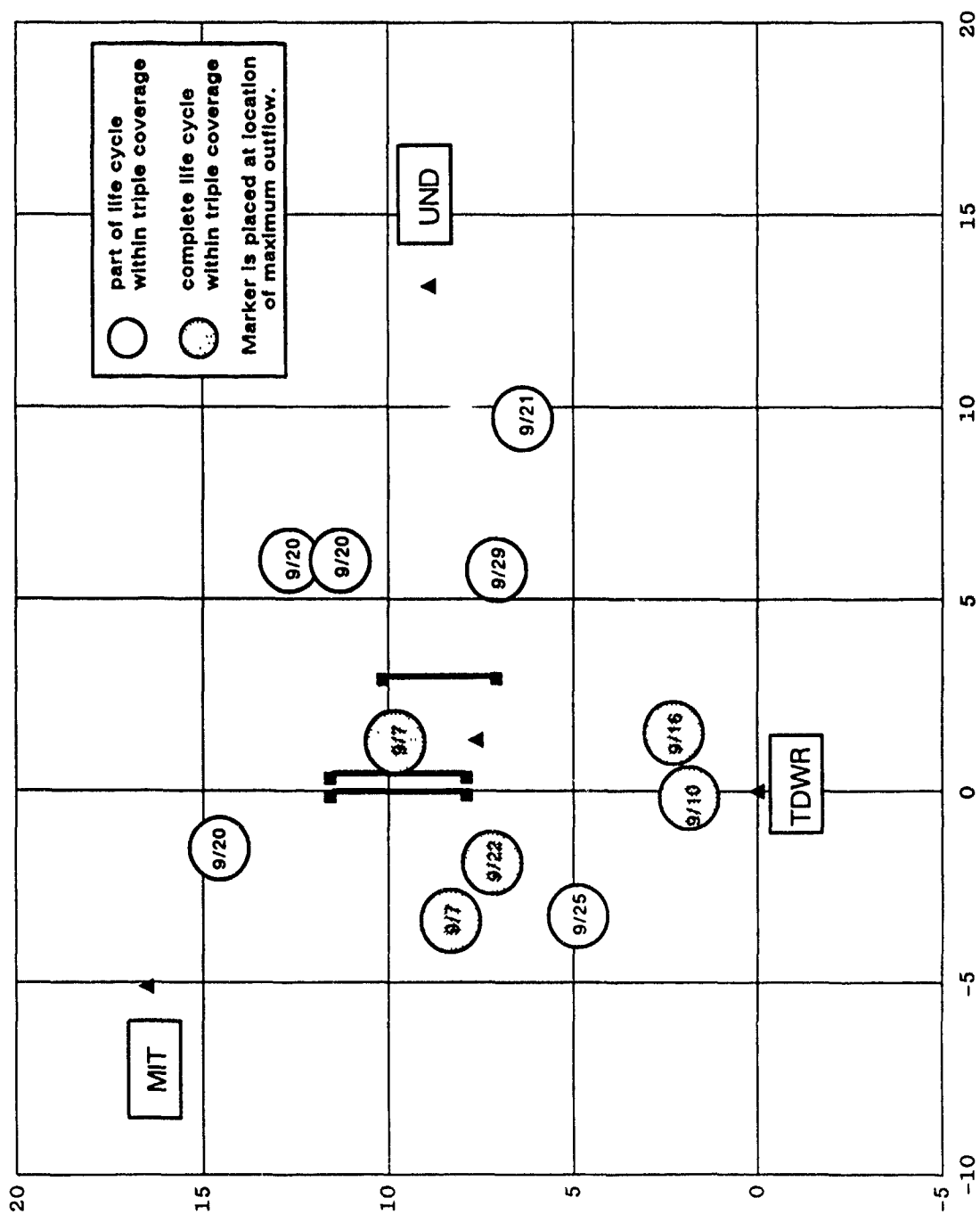


Figure 12. Location of triple Doppler microburst events during September, 1991.

3. TRIPLE DOPPLER CASES

In this chapter, detailed information about each triple Doppler day is given. Table 1 gives a complete summary of all the microburst events for which triple Doppler coverage is available, and includes the location of the event relative to the TDWR testbed radar, the maximum differential outflow velocity recorded by that radar, and a notation as to whether the entire life cycle of the storm was recorded. Table 2 gives a summary of all of the supporting sensor data available for each triple Doppler day.

The rest of this chapter consists of detailed information about each triple Doppler day in the form of an Information Sheet detailing the available supporting data and the radar coverage, and a Sketch depicting the storm(s) in plan view and vertical cross-section format. To illustrate the use of the Information Sheet and Sketches, samples explaining them are first given.

Table 1. Summary of all triple Doppler microburst events observed in Orlando, 1991. Location is relative to TDWR testbed radar.

DATE	TIME OF MAXIMUM OUTFLOW (UT)	LOCATION OF MAXIMUM OUTFLOW (range / azimuth)	MAXIMUM DIFFERENTIAL VELOCITY (m/s)	ENTIRE CELL HISTORY
June 15	1954	15 / 013	14	✓
June 16	2258	07 / 049	37	✓
June 17	1859	08 / 038	15	✓
	1909	12 / 032	20	✓
	1914	10 / 031	24	✓
	1915	09 / 048	17	✓
June 18	2047	11 / 003	14	
June 19	1716	09 / 007	22	✓
June 20	2118	07 / 017	14	✓
	2123	08 / 006	24	✓
June 21	2054	09 / 017	12	✓
June 22	2209	05 / 355	13	
June 23	2357	08 / 031	17	✓
June 25	1935	04 / 342	21	
July 28	2233	16 / 041	14	
	0017	10 / 349	12	
July 29	2347	10 / 313	33	
July 31	1740	05 / 357	11	
August 2	2116	10 / 019	14	
	2130	20 / 026	17	

Table 1 (continued). Summary of all triple Doppler microburst events observed in Orlando, 1991. Location is relative to TDWR testbed radar.

DATE	TIME OF MAXIMUM OUTFLOW (UT)	LOCATION OF MAXIMUM OUTFLOW (range / azimuth)	MAXIMUM DIFFERENTIAL VELOCITY (m/s)	ENTIRE CELL HISTORY
August 5	1755	14 / 037	14	
August 9	1931	12 / 353	40	✓
	1943	08 / 017	45	✓
	1944	05 / 020	21	✓
	1945	09 / 019	16	✓
	1947	06 / 011	31	✓
	1951	05 / 059	27	✓
	1958	07 / 049	30	✓
	1959	09 / 068	20	✓
August 10	2059	11 / 024	16	✓
	2101	14 / 015	32	✓
	2105	13 / 028	20	✓
	2111	16 / 029	17	✓
	2114	14 / 051	14	✓
	2238	07 / 040	23	✓
August 12	2253	17 / 006	17	
August 15	1944	07 / 349	17	✓
	1948	13 / 034	12	✓
	1952	09 / 356	22	✓
	1952	08 / 020	21	✓

Table 1 (continued). Summary of all triple Doppler microburst events observed in Orlando, 1991. Location is relative to TDWR testbed radar.

DATE	TIME OF MAXIMUM OUTFLOW (UT)	LOCATION OF MAXIMUM OUTFLOW (range / azimuth)	MAXIMUM DIFFERENTIAL VELOCITY (m/s)	ENTIRE CELL HISTORY
	2003	09 / 030	22	✓
August 19	1839	06 / 355	14	
August 24	1859	06 / 315	14	
August 25	2215	13 / 049	11	✓
August 30	1741	07 / 020	12	✓
August 31	2032	11 / 019	24	✓
	2049	09 / 359	25	✓
	2055	08 / 341	14	✓
	2058	10 / 327	33	✓
September 7	2047	09 / 337	16	✓
	2047	10 / 006	14	✓
September 10	1817	02 / 351	16	✓
September 16	1756	03 / 029	14	✓
September 20	1906	14 / 025	14	
	1909	13 / 028	16	
	2340	15 / 354	16	
September 21	1740	12 / 057	10	
September 22	1716	08 / 347	12	✓
September 25	1755	06 / 326	18	
September 29	1615	09 / 038	12	

Table 2. Checklist of supporting sensor data available for triple Doppler cases.
Lightning data refers to SAFIR interferometer data.

DATE	AIRCRAFT DATA	SAFIR LIGHTNING DATA	MESONET DATA	CORONA POINT DATA	ACARS DATA	AWOS DATA	ASR-WSP DATA
June 15	✓				✓	✓	✓
June 16					✓	✓	✓
June 17	✓				✓	✓	✓
June 18	✓			✓	✓	✓	✓
June 19	✓			✓	✓	✓	✓
June 20	✓			✓	✓	✓	✓
June 21					✓	✓	✓
June 22				✓	✓	✓	✓
June 23				✓	✓	✓	✓
June 25				✓	✓	✓	✓
July 28			✓		✓	✓	✓
July 29			✓	✓	✓	✓	✓
July 31			✓	✓	✓	✓	✓
August 2			✓	✓	✓	✓	✓
August 5			✓	✓	✓	✓	✓
August 9			✓	✓	✓	✓	✓
August 10			✓	✓	✓		✓
August 12			✓	✓	✓	✓	✓
August 15					✓	✓	✓
August 19				✓	✓	✓	✓
August 24	data not in			✓	✓	✓	
August 25	data not in		✓	✓	✓	✓	
August 30	data not in		✓	✓	✓	✓	✓
August 31			✓	✓	✓	✓	✓
September 7			✓		✓	✓	
September 10			✓		✓	✓	
September 16			not processed		✓	✓	✓
September 20		✓	not processed	✓	✓	✓	
September 21		✓	not processed		✓	✓	
September 22		✓	not processed	✓	✓	✓	
September 25		✓	not processed		✓	✓	✓
September 29		✓	not processed	✓	✓	✓	

SAMPLE INFORMATION SHEET

Description: The weather during the triple Doppler period is described, including the storm scenario and the sounding characteristics (winds aloft, surface temperature and dew point, and lifted condensation level [indicates cloud base]). Wind speeds are classified as light (0 – 10 mph), moderate (11 – 25 mph), and strong (26 – 50 mph). All altitudes are given in m or km AGL.

The accompanying sketch is also described. The storm which produces the largest microburst during the period, and has good triple coverage is typically sketched. Where room permits, other cells may also be included.

All times referred to on the information sheets and accompanying sketches are in GMT.

Triple Doppler Times: Time period(s) Radars

Total Coverage Times: Time period, Radar

The complete period of operation for each radar for the given day.

Site Observations: Event (max ΔV) time of max ΔV (location) MCO symbol(s)
where event is MB or GF
max ΔV is in m/s
time is that of max ΔV
location of max ΔV in the form (range/azimuth) relative to TDWR
MCO notation for those events that impacted the airport
symbol \checkmark is for an event considered to be a good triple Doppler case
symbol \dagger is for an event which is shown in the accompanying sketch page.

Dual Doppler Times: Time period(s) Radars

RHI Scans: Radar
Time period, direction

List of the time period and general direction of RHI scans for each radar during the total Doppler coverage period.

ASR-WSP data: Time period(s)

Sounding Times: List of the time of each sounding for the day.

Aircraft data: Yes, brief description and time period or None.

ACARS data: Yes or None.

Mesonet and LLWAS data: Triple Doppler time period

Station#	% good	Station #	% good
.	.	.	.
.	.	.	.

The mesonet data summary is presented for each triple Doppler time period separately. Station numbers (Station#) are displayed in the standard format currently in use where stations 1-15 are mesonet, 16-24 are nine station LLWAS and 25-30 are six station LLWAS. The locations of all the stations are shown in Fig. 5. "% good" refers to the percentage of good data over the entire triple Doppler time period. No distinction is made between bad and missing data. Station statistics are calculated from preprocessed mesonet and LLWAS data; therefore additional data may be available. No data have been processed after September 9, 1991, but may be available upon request.

AWOS data: Yes or None.

Interferometer data: Yes, time period for lightning data collection or None.

Corona point data: Triple Doppler time period.
Corona point sensors listed as C#.

Appendix A gives the association between corona point sensors and corona point stations throughout the data collection period. The corona point station locations are shown in Fig. 6.

SAMPLE SKETCH

DATE

TDWR Surface Scans.

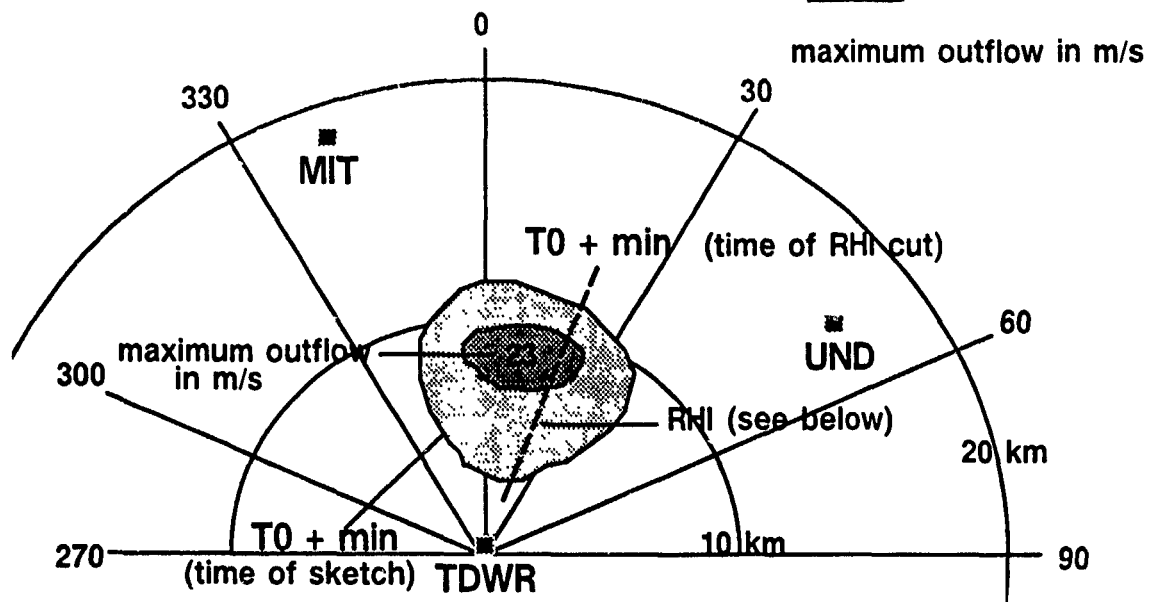
T0 = time of beginning of triple period



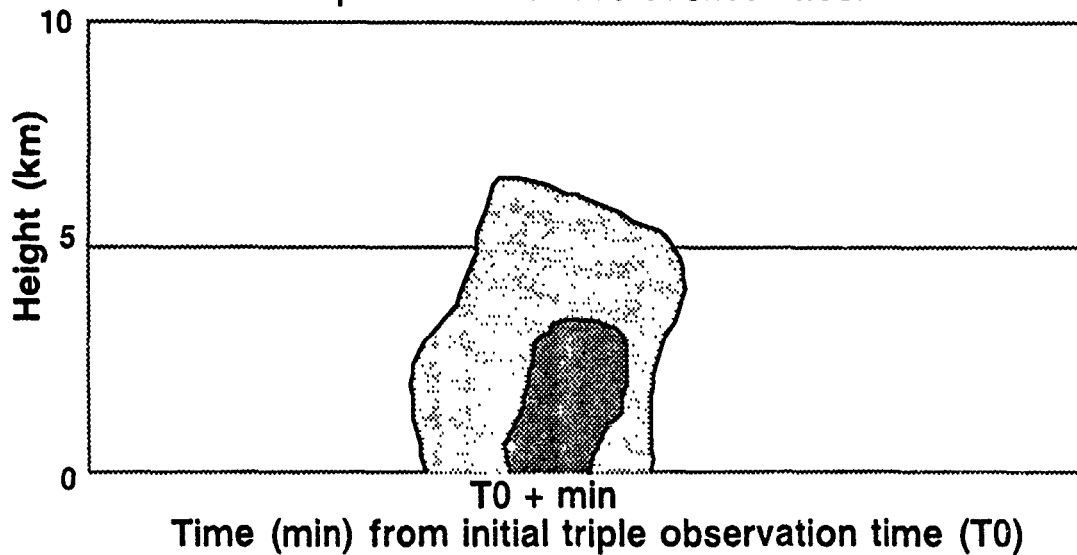
15-40 DBZ

40-55 DBZ

>55 DBZ



RHI plots from above dashed lines.



15 JUNE 91

Description: A large cell moved slowly from the WNW to the ESE, and divided into two separate cells after a small microburst was produced. The northernmost cell dissipated, while the southern cell produced a second weak microburst. The sounding taken at 2028 GMT showed light and variable winds below the freezing level (4.5 km), with increasingly stronger northerly winds above. The surface temperature was 29.1°C, the dew point was 18.3°C, and the lifted condensation level was 0.9 km.

The accompanying sketch shows the position of the cell at T_0 , moving into the triple Doppler region. The cell produced a microburst outside of the triple region at $T_0 + 19$ min, and divided into two separate cells at $T_0 + 29$ min (not shown). The northernmost cell dissipated, and the other is shown at its position at $T_0 + 49$ min, the time of maximum outflow.

Triple Doppler Times: 1905 - 2045 MIT/UND/TDWR
2126 - 2150

Total Coverage Times: 1310 - 2300, TDWR
1852 - 2202, UND
1759 - 2242, MIT

Site Observations: MB (14 m/s) 1954 (15/013), MCO ✓†
GF (8 m/s) 2049 (11/007), MCO
MB (14 m/s) 2116 (10/043)

Dual Doppler Times: 1852 - 1905 UND/TDWR
2045 - 2126 UND/TDWR
2153 - 2202 UND/TDWR*

*Scanning < 9° for UND between 2159 - 2202

RHI Scans: MIT
1801 - 1805, NW/N/NE
1805 - 1806, SW
1807 - 1819, N
1827 - 1828, NE
2202 - 2240, NW/NE/SE
UND
2152 - 2153, SE
TDWR
2242, 2247, 2252 - 2253, 2258, SE

ASR-WSP data: 1854 - 1912
2035 - 2055
2058 - 2141

Sounding Times: 1154, 1513, 1748, 2028

Aircraft data: Yes, MB penetrated between 1927 - 2031

ACARS data: Yes

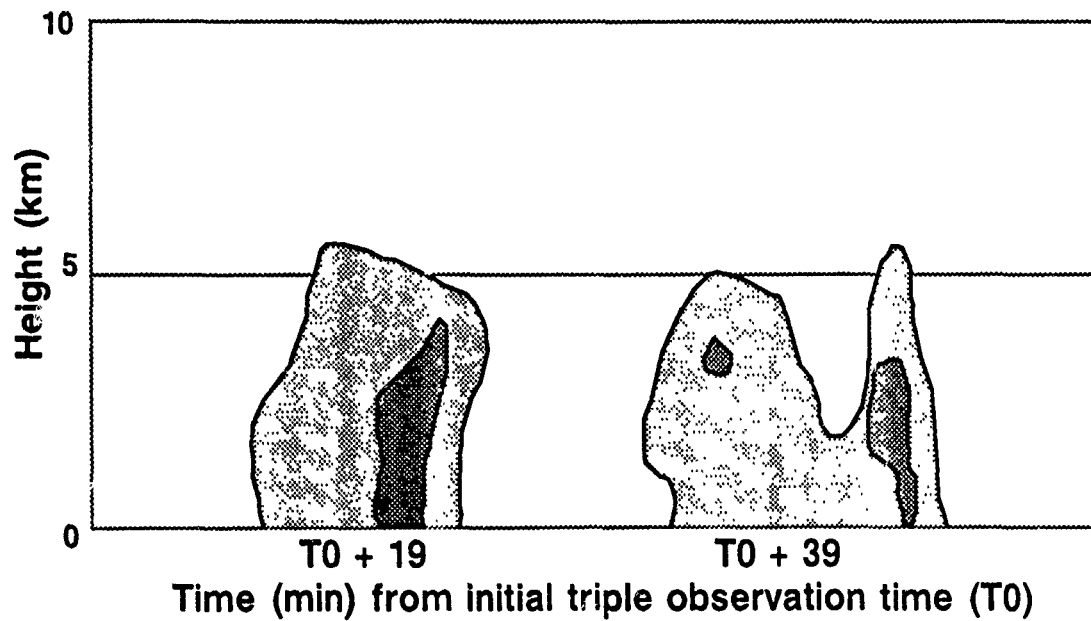
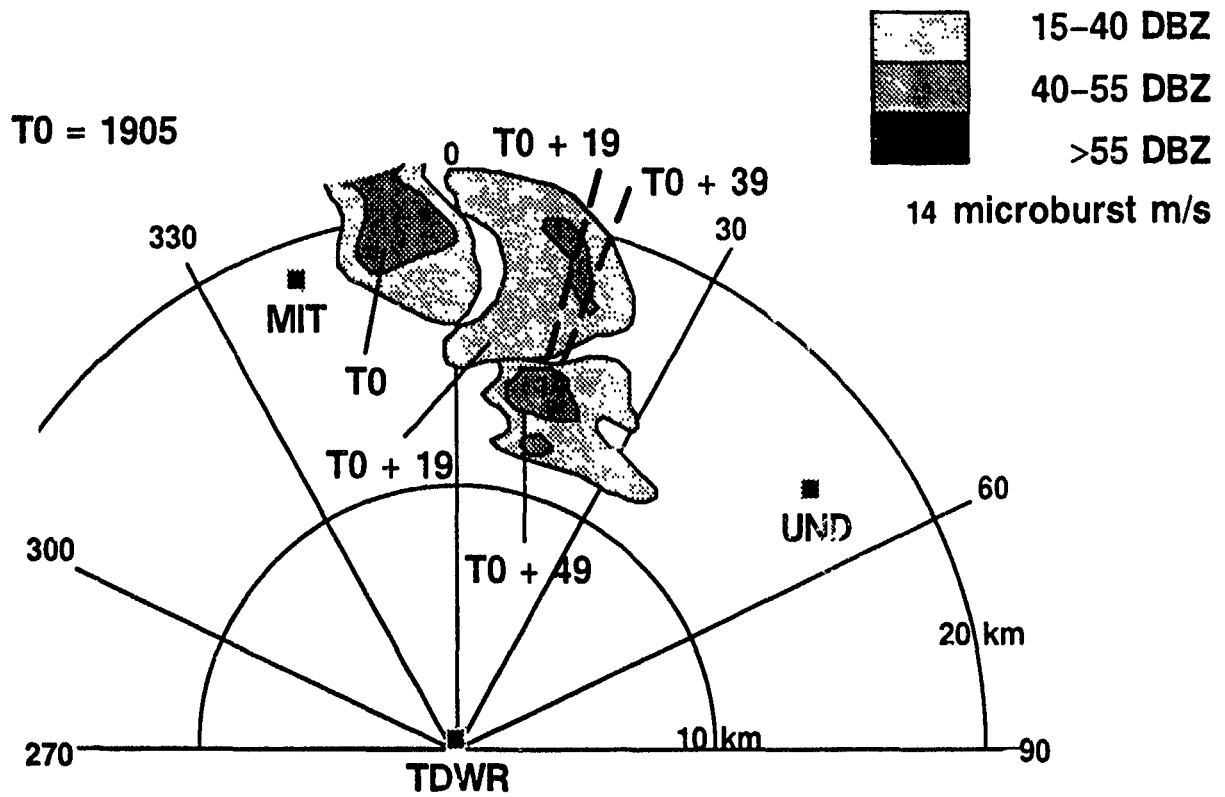
Mesonet and LLWAS data: None

AWOS data: Yes

Interferometer data: None

Corona point data: None

15 JUNE 91



16 JUNE 91

Description: A weak seabreeze front moving in from the west coast triggered rapid growth in a small cell close to the TDWR testbed. This cell merged with other tiny, rapidly developing cells, forming a large complex that moved slowly to the E. This complex produced many microbursts, the strongest of which was 37 m/s. The sounding taken at 2028 GMT showed light and variable winds below the freezing level (4.9 km), and north-northwesterly winds, slowly increasing with height, above. The surface temperature was 31.3°C, the dew point was 18.1°C, and the lifted condensation level was 1.1 km.

The accompanying sketch shows the developing cell at $T_0 + 13$ min, which forms the large, multicell complex at $T_0 + 41$ min. This storm produced a 37 m/s outflow at $T_0 + 41$ min. The RHI at $T_0 + 44$ min shows a new core forming aloft at 5 km altitude.

Triple Doppler Times: 2217 - 2319 MIT/UND/TDWR

****Important Note --** More triple Doppler coverage may have been available if the archived tape from MIT, JUN16B, could have been inventoried. This tape was not readable and the Doppler coverage time shortened. However, no alarms were given for MCO during this void time (1901 - 2217).

Total Coverage Times: 1536 - 0015, TDWR
2131 - 2357, UND
1837 - 1901, 2217 - 2319, MIT

Site Observations: MB (20 m/s) 2221 (10/342), MCO
MB (14 m/s) 2231 (04/056), MCO
MB (28 m/s) 2241 (05/015), MCO
MB (15 m/s) 2241 (02/020), MCO
MB (12 m/s) 2250 (09/024), MCO
MB (37 m/s) 2258 (07/049), MCO ✓†
GF (7m/s) (18/344), MCO

Dual Doppler Times: 2145 - 2341 UND/TDWR, over airport.

RHI Scans: MIT
1839 - 1840, SE
1842 - 1843, NE
UND
2341 - 2345, 2349 - 2353, NE/E/SE

ASR-WSP data: 1610 - 1620
2145 - 2158
2204 - 2223
2236 - 2317

Sounding Times: 1149, 1448, 1755, 2028

Aircraft data: 1739 - 1823. Significant weather was not encountered during this flight.
Aircraft data are not available for the microburst alarm given after 2200.

ACARS data: Yes

Mesonet and LLWAS data: None

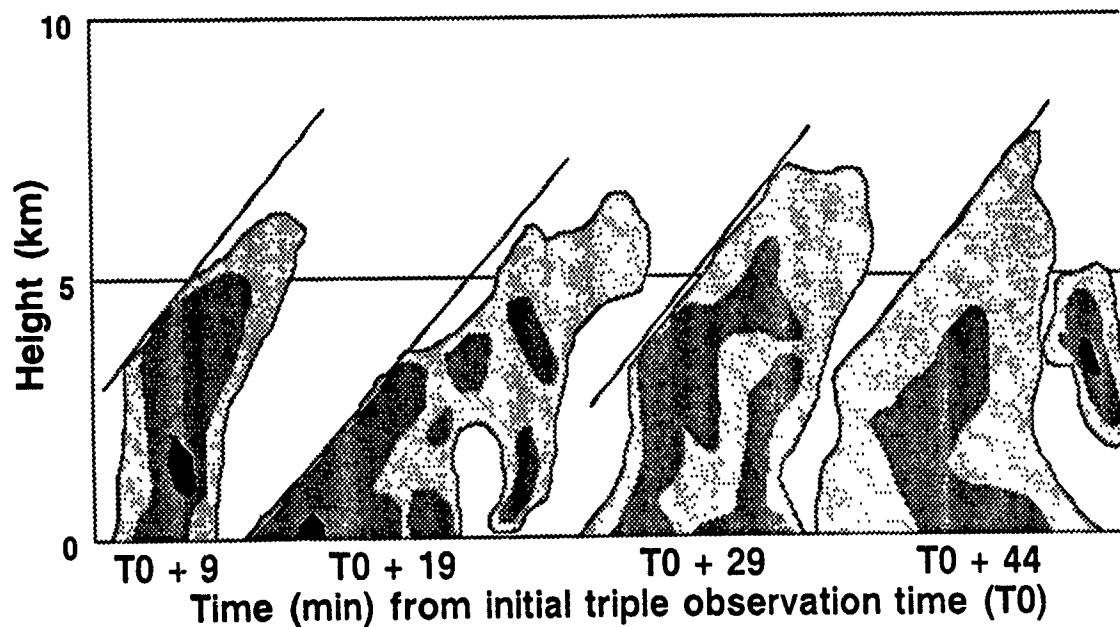
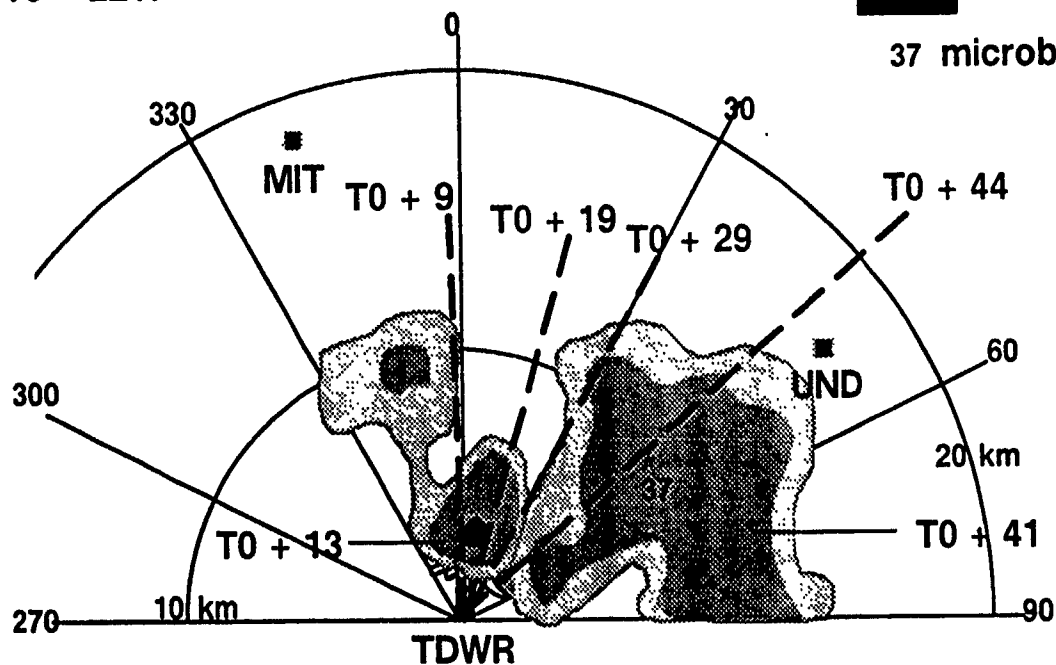
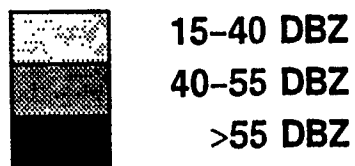
AWOS data: Yes

Interferometer data: None

Corona point data: None

16 JUNE 91

T0 = 2217



17 JUNE 91

Description: A NE/SW oriented gust front produced by a group of old thunderstorms passed through the triple Doppler region in advance of a small line of thunderstorms. The gust front initiated new development along the southern end of the line, which continued until a significant line of strong thunderstorms had been produced. The sounding taken at 1741 GMT showed light to moderate southwesterly winds below the freezing level (4.8 km), and light and variable westerly winds above. The surface temperature was 26.1°C, the dew point was 17.8°C, and the lifted condensation level was 0.7 km.

The accompanying sketch shows the initial group of cells as they entered the triple Doppler region at T_0 , and how new development along the southern edge of the group produced a significant line of thunderstorms by $T_0 + 46$ min.

Triple Doppler Times: 1749 - 1800 MIT/UND/TDWR*
1803 - 1819
1828 - 1940

*Scanning < 9° for UND between 1749 - 1800.

Important Note -- MIT was scanning between 60 and 80 degrees between 1819 and 1828, explaining the 9 minute gap of triple Doppler coverage.

Total Coverage Times: 1530 - 2259, TDWR
1737 - 1940, UND
1621 - 1953, MIT

Site Observations: GF (12 m/s) 1819 (05/344), MCO
MB (16 m/s) 1831 (16/355), MCO
MB (13 m/s) 1852 (03/038), MCO
MB (18 m/s) 1855 (04/042), MCO
MB (15 m/s) 1859 (08/038), MCO ✓
MB (11 m/s) 1859 (14/025)
MB (20 m/s) 1909 (12/032), MCO ✓
MB (24 m/s) 1914 (10/031), MCO ✓†
MB (17 m/s) 1915 (09/048), MCO ✓

Dual Doppler Times: 1737 - 1749 UND/TDWR*
1940 - 1953 MIT/TDWR

*Scanning < 9° for UND between 1737 - 1749.

RHI Scans: MIT
1621 - 1650, SE
1650 - 1744, W/NW/N
1744 - 1748, SW

ASR-WSP data: 1821 - 1902
1909 - 1939

Sounding Times: 1156, 1448, 1741, 2026, 2128

Aircraft data: Yes, gust front and microbursts were penetrated between 1742 - 1938

ACARS data: Yes

Mesonet and LLWAS data: None

AWOS data: Yes

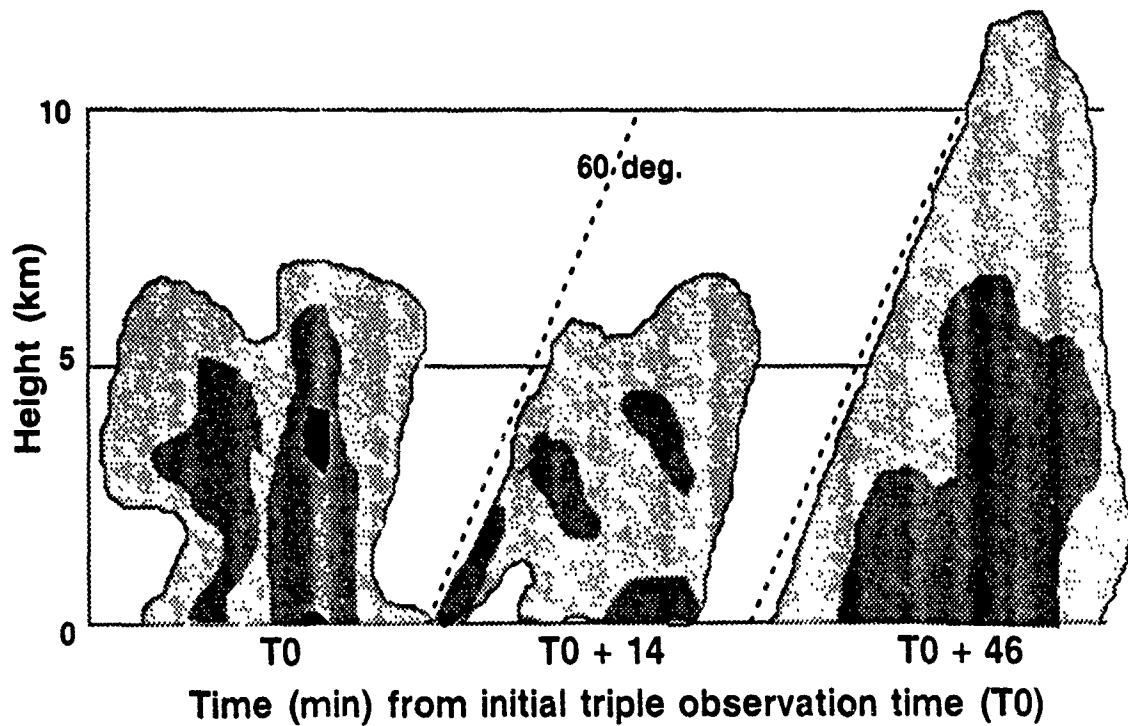
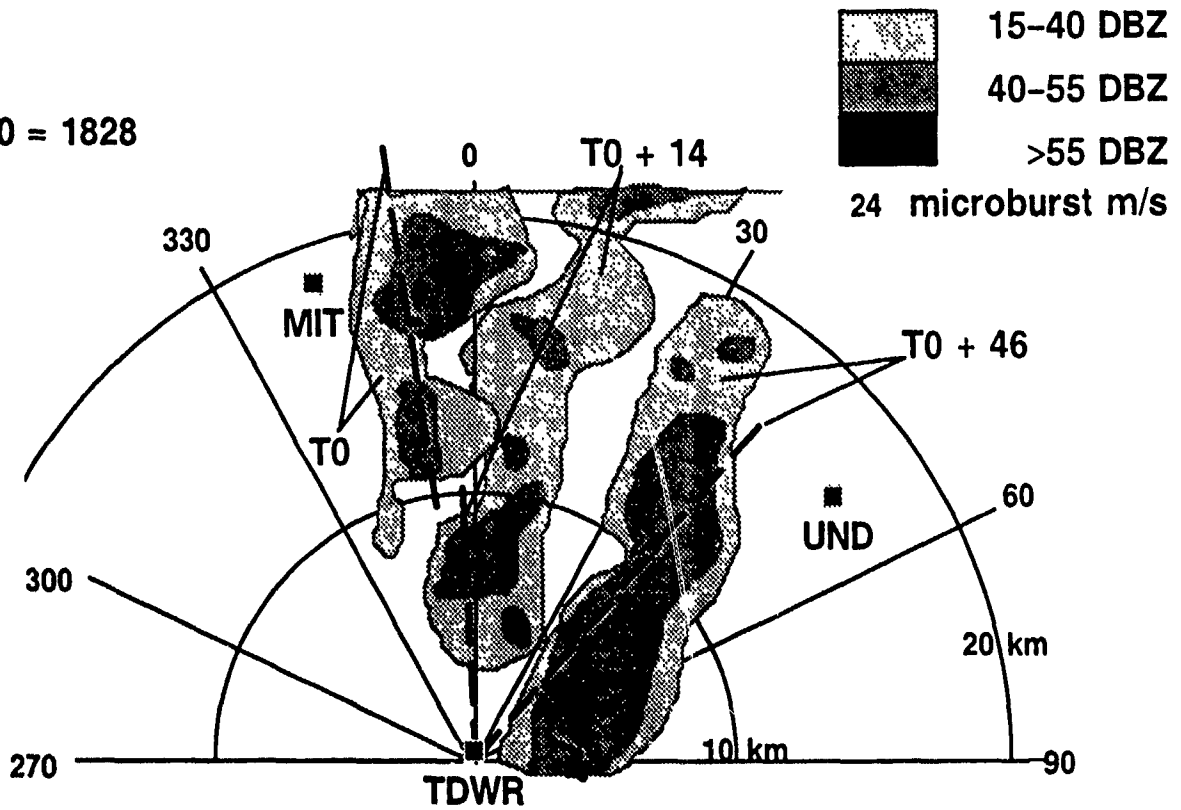
Interferometer data: None

Corona point data: None

Other Notes: Gust front highly visible approximately 8 km ahead of squall line and movement was to the SE at 24 km/hr.

17 JUNE 91

T0 = 1828



18 JUNE 91

Description: At the beginning of the triple Doppler period, a cell was located due north of the TDWR testbed. While it slowly moved eastward and dissipated (after producing a weak microburst) two more small cells formed to the S. These cells dissipated rapidly, without growing to any substantial height. The sounding taken at 2047 GMT showed light and variable winds from the surface to 16 km. The surface temperature was 28.2°C, the dew point was 20.8°C, the freezing level was 4.7 km, and the lifted condensation level was 0.6 km.

The accompanying sketch shows the movement of the first cell from its beginning at T_0 to its dissipation at $T_0 + 35$ min. The two later-forming cells that began at $T_0 + 35$ min are also shown.

Triple Doppler Times: 2037 - 2116 MIT/UND/TDWR

Total Coverage Times: 1512 - 2122, TDWR
1801 - 2116, UND
1921 - 2140, MIT

Site Observations: MB (14 m/s) 2047 (11/003), MCO ✓†

Dual Doppler Times: 1801 - 1918 UND/TDWR, over airport
2117 - 2122 MIT/TDWR, to NE

RHI Scans: MIT
1921 - 2023, NE/SE
2023 - 2037, SE
2122 - 2140, SE

ASR-WSP data: 2043 - 2059

Sounding Times: 1300, 1550, 1850, 2047

Aircraft data: 1856 - 2118, 13 m/s mb observed at 2048 near runway

ACARS data: Yes

Mesonet and LLWAS data: None

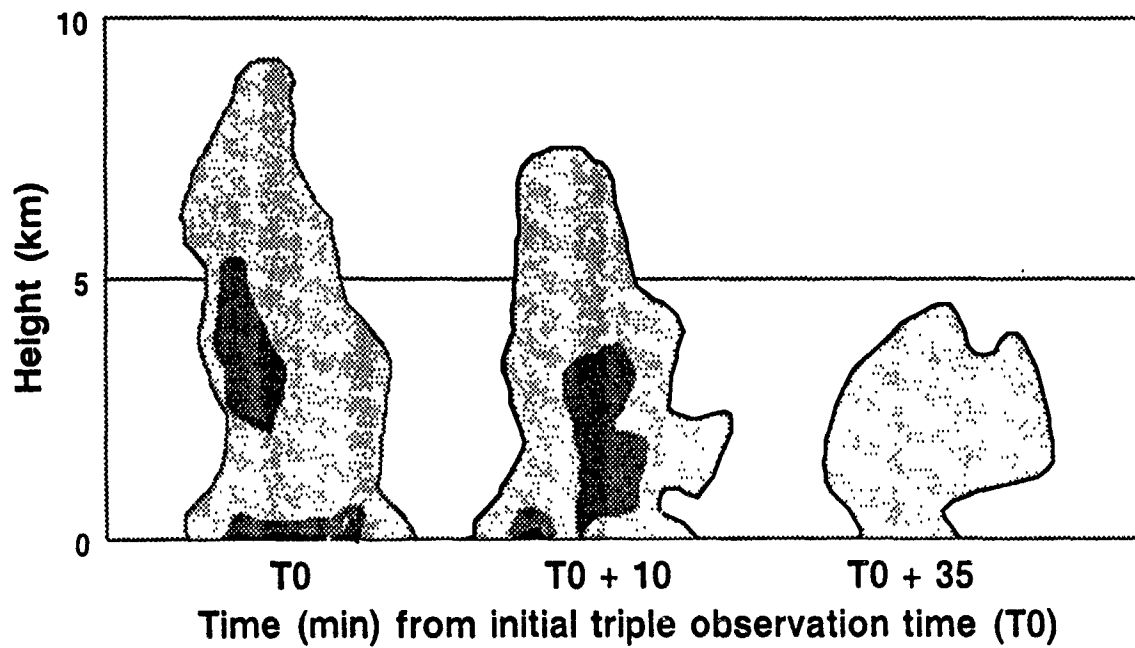
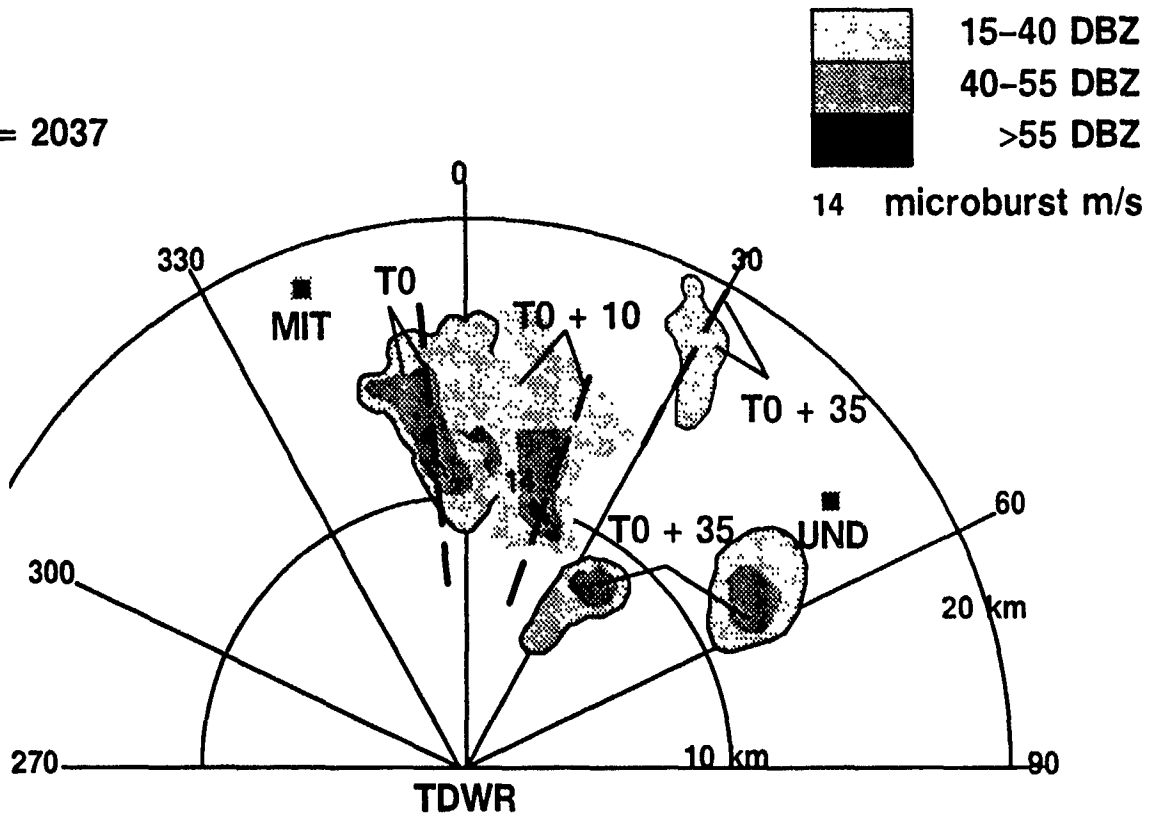
AWOS data: Yes

Interferometer data: None

Corona point data: 2037 – 2116
Stations C24, C14, C7

18 JUNE 91

T0 = 2037



19 JUNE 91

Description: In the first triple Doppler period a few cells were forming in the triple region and moving to the ENE. One cell developed rapidly as it crossed the triple region, producing a 20 m/s microburst. A second cell formed just to the north, growing as the first cell dissipated. The sounding taken nearest this time, at 1748 GMT, showed light and variable winds throughout the layer. The surface temperature was 28.9°C, the dew point was 20.4°C, the freezing level was 5.0 km, and the lifted condensation level was 0.7 km. The second triple period occurred an hour after that and was short (15 min) with no microbursts. During the third triple period an hour and a half later, the eastern seabreeze moved to the W, triggering cells behind it. Most remained outside of the triple region. The sounding taken nearest to this time, at 2051 GMT, showed light westerly winds at the surface and moderate southwesterly winds to the freezing level (5.1 km), and moderate, variable winds above. The surface temperature was 17.5°C, the dew point was 17.0°C, and the lifted condensation level was 0.0 km.

The accompanying sketch shows the cell that produced the 20 m/s microburst developing in the triple region, starting at $T_0 + 15$ min. At $T_0 + 48$ min, the second cell is beginning to form just to the north, and by $T_0 + 70$ min the first cell has dissipated. The first RHI shows the cell before the time of maximum outflow, and the second RHI shows the cell at the time of maximum outflow.

Triple Doppler Times: 1628 - 1742 MIT/UND/TDWR*
1843 - 1900
2024 - 2221

*Scanning < 7° for MIT, 1713 - 1724, < 3° for MIT, 1725 - 1742, < 3° for UND, 1713 - 1743, and < 15° for UND, 2139 - 2149.

Total Coverage Times: 1535 - 2259, TDWR
1619 - 2229, UND
1507 - 2231, MIT

Site Observations: MB (22 m/s) 1716 (09/007), MCO ✓†
MB (10 m/s) 1722 (15/025), MCO
GF (10 m/s) 2057 (14/034), MCO
GF (9 m/s) 2112 (09/020), MCO

Dual Doppler Times: 1623 - 1628 UND/TDWR
1743 - 1843 UND/TDWR*
1900 - 2024 UND/TDWR**
2221 - 2229 UND/TDWR

*Scanning < 9° for UND, 1758 – 1811.

**Scanning < 9° for UND, 1918 – 1956.

RHI Scans: MIT
1507 – 1624, SE/E
1752 – 1815, SW
1818, 1828 – 1841, SW/W/NW/N/NE
1903 – 2019, NE/E/SE
2223 – 2230, SW

ASR-WSP data: 1640 – 1725
1903 – 1925
2050 – 2111
2114 – 2157

Sounding Times: 1148, 1446, 1748, 2051

Aircraft data: Yes, Divergence encountered between 1727 – 1742

ACARS data: Yes

Mesonet and LLWAS data: None

AWOS data: Yes

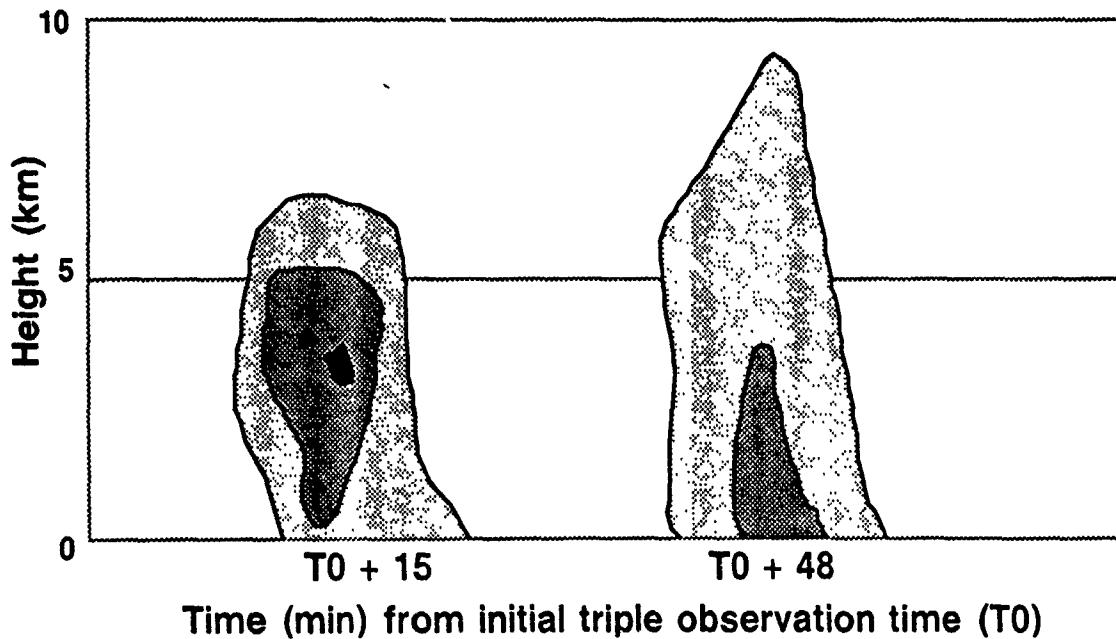
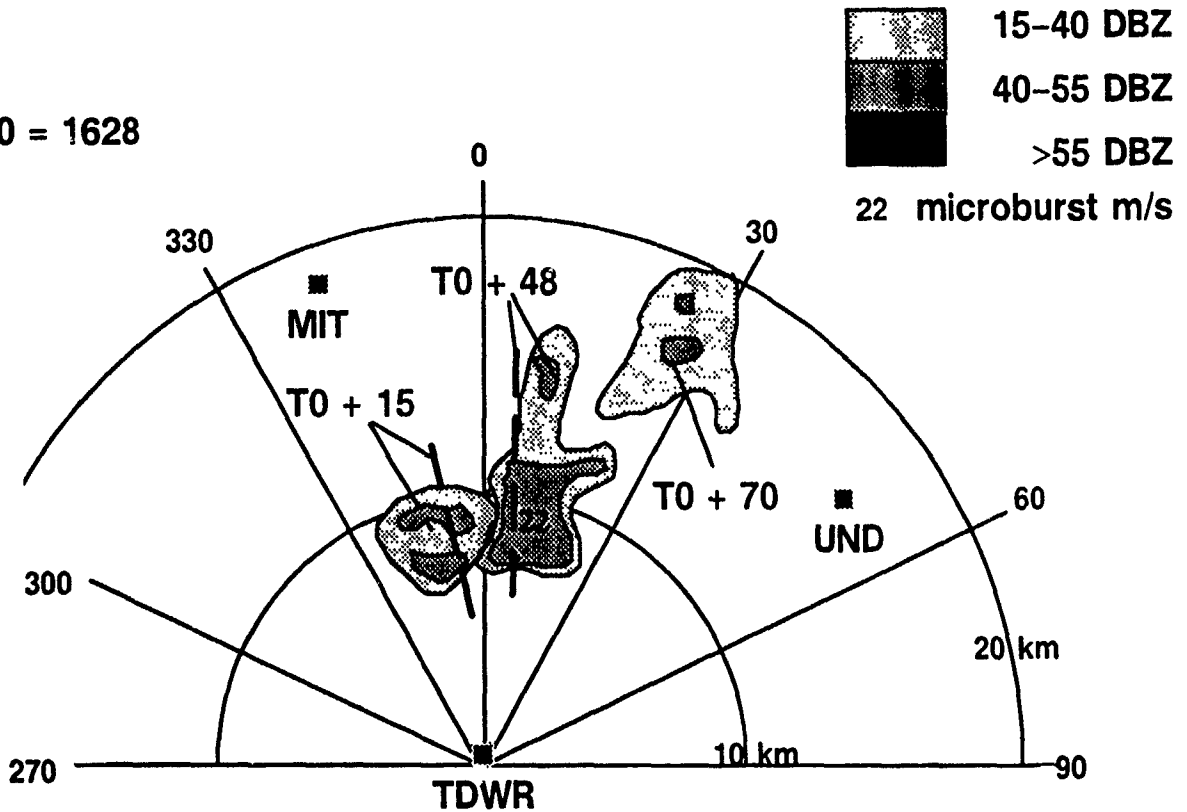
Interferometer data: None

Corona point data: 1628 – 1742
Stations C24, C7, C3
1843 – 1900
Stations C7, C6
2024 – 2221
Stations C24, C14, C7, C3, C6, C1

Other Notes: MB (18 m/s) to East at 2119 is captured by the full surface scan, but not the volume collected by TDWR. Therefore, this MB is not included in any statistics done for triple Doppler coverage in 1991.

19 JUNE 91

T0 = 1628



20 JUNE 91

Description: A gust front produced by an old thunderstorm passed through the triple Doppler area from the NW to the SE, triggering the development of a new cell. The thunderstorm moved slowly westward, but stayed within the triple Doppler region throughout its lifetime. This cell produced two microbursts, the strongest of which was 25 m/s. The sounding taken at 2035 GMT showed light and variable winds from the surface to 13 km. The surface temperature was 30.8°C, the dew point was 20.8°C, the freezing level was 4.8 km, and the lifted condensation level was 0.9 km.

The accompanying sketch shows the cell at $T_0 + 59$ min, the time of maximum surface outflow strength. The RHIs show the cell in varying stages of development.

Triple Doppler Times: 2024 - 2145 MIT/UND/TDWR

****Important Note --** Various Volume Scans were taken by MIT and UND resulting in limited triple Doppler coverage at certain times. However, the low storm levels were observed by the three radars during the triple Doppler times given. Shallow volumes were collected at the following times:

2100 - 2139,	MIT
2058 - 2138,	UND

Total Coverage Times:

1544 - 2335,	TDWR
1820 - 2307,	UND
1658 - 2145,	MIT

Site Observations: GF (8 m/s) 2105 (06/017), MCO
MB (14 m/s) 2118 (07/017) ✓
MB (24 m/s) 2123 (08/006), MCO ✓†

Dual Doppler Times: 1820 - 2307 UND/TDWR, over airport

RHI Scans:

MIT
1658 - 2000, NW, and full 360° with 20° azimuth increments
2003 - 2023, NE
UND
2202 - 2203, NE

ASR-WSP data: 2109 - 2152

Sounding Times: 1214, 1446, 1749, 2035

Aircraft data: 1905 – 2137. Direct hit through microburst at 2045, 8 nm final for runway 18. (A marginal microburst at best according to velocity field recorded by TDWR radar, also not in the favorable triple Doppler region.) Aborted landing at 2127 due to 50 knot loss reported by ATC for runway 18.

ACARS data: Yes

Mesonet and LLWAS data: None

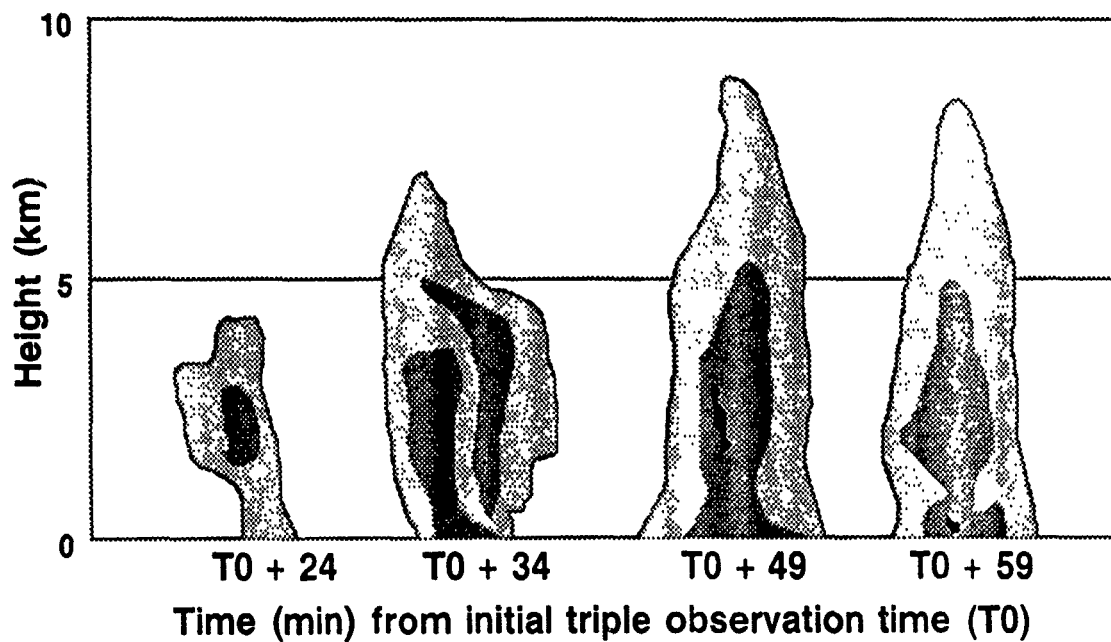
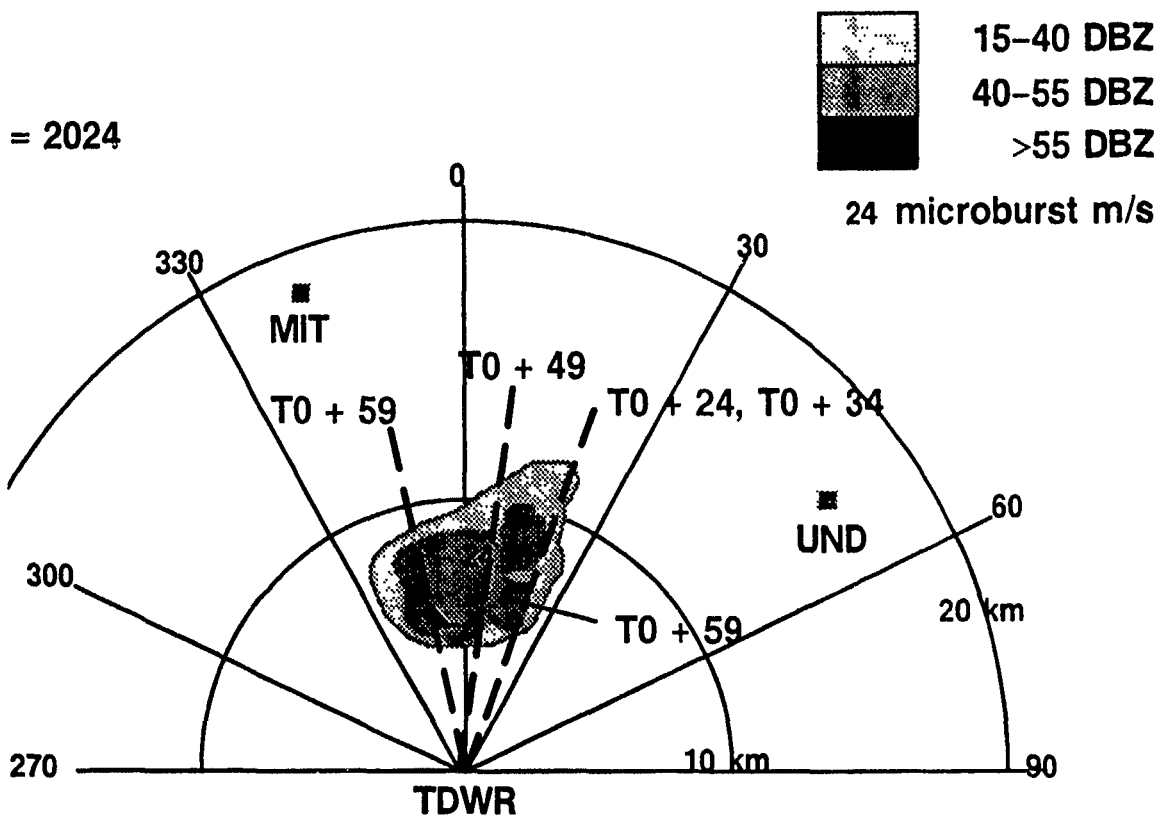
AWOS data: Yes

Interferometer data: None

Corona point data: 2024 – 2145
Stations C24, C14, C7, C3, C6, C1

20 JUNE 91

T0 = 2024



21 JUNE 91

Description: Many cells were present on this day, but most were outside the triple Doppler region. Two of the cells within the region, one of which had produced a weak microburst, merged to form a larger thunderstorm. The resultant cell moved to the E, quickly dissipating after producing a weak microburst. The sounding taken at 2028 GMT showed highly variable winds below the freezing level (4.9 km). They were light and variable up to 3 km, where the winds became moderate from the SSW. Above the freezing level the winds were very strong from the SW. The surface temperature was 25.3°C, the dew point was 20.5°C, and the lifted condensation level was 0.4 km.

The accompanying sketch shows the position of the two original cells at T_0 . The larger of the two was responsible for a weak microburst. The sketch also shows the large thunderstorm resulting from the merge of the two cells at $T_0 + 13$ min, the time of maximum outflow strength.

Triple Doppler Times: 2041 - 2113 MIT/UND/TDWR

Total Coverage Times: 1544 - 2113, TDWR
1841 - 2117, UND
2041 - 2222, MIT

Site Observations: GF (14 m/s) 1908 (11/001), MCO
MB (13 m/s) 1930 (10/333), MCO
MB (15 m/s) 2019 (15/041), MCO
MB (21 m/s) 2030 (10/344), MCO
MB (12 m/s) 2054 (09/017), MCO ✓†

Dual Doppler Times: 1841 - 2041 UND/TDWR

RHI Scans: None

ASR-WSP data: 2026 - 2109

Sounding Times: 1154, 1445, 1752, 2028

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

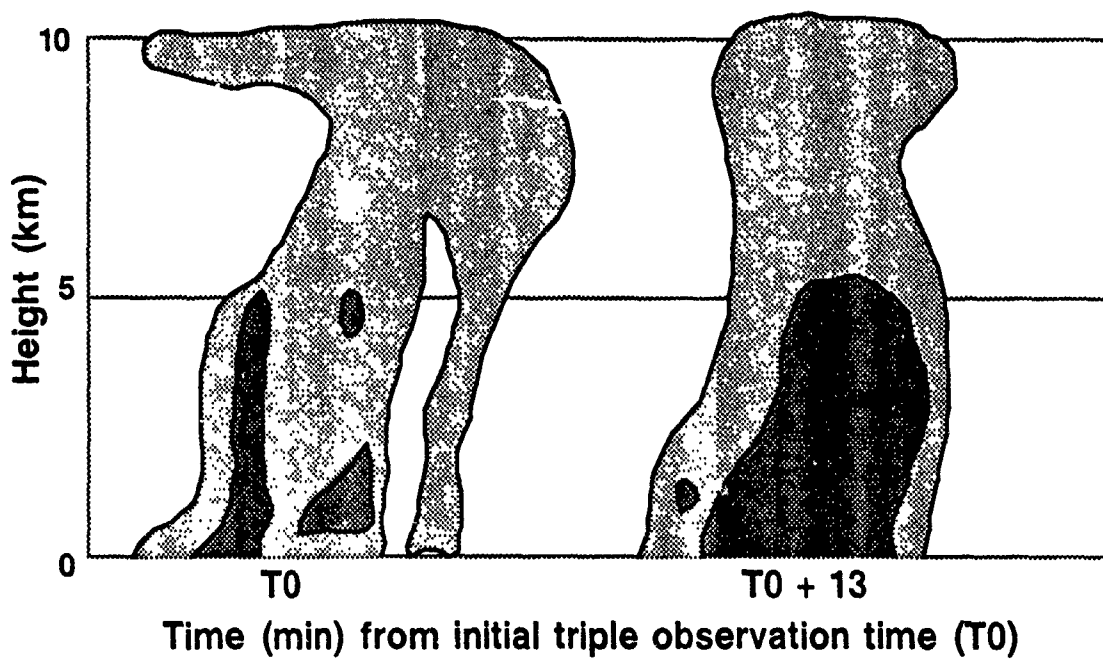
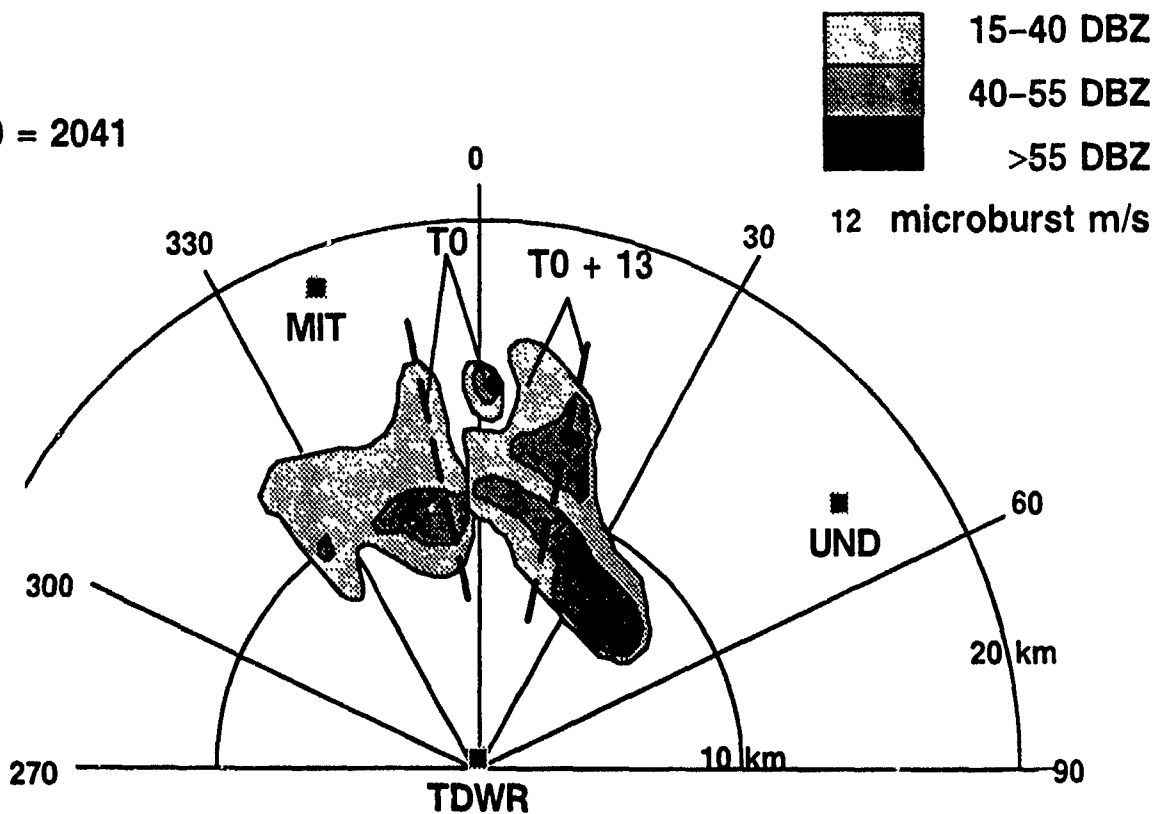
AWOS data: Yes

Interferometer data: None

Corona point data: None

21 JUNE 91

T0 = 2041



22 JUNE 91

Description: A small cell developed just to the north of the TDWR testbed, and remained essentially stationary throughout its short lifetime. The cell grew and dissipated quickly, producing a weak microburst. The sounding taken at 2045 GMT showed light southwesterly winds below the freezing level (4.8 km), and stronger winds from the SW above. The surface temperature was 31.1°C, the dew point was 19.7°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the cell at $T_0 + 9$, just north of the TDWR testbed. It remained close to this position throughout its life cycle. The RHIs of this cell show that it did not grow to any substantial height.

Triple Doppler Times: 2200 - 2305 MIT/UND/TDWR*

*Scanning < 9° for UND, 2204 - 2207, and < 3° for UND, 2207 - 2209.
Scanning < 22° for TDWR, 2200 - 2202, and < 36° for TDWR, 2203 - 2205.

Total Coverage Times: 1526 - 2312, TDWR
1903 - 2305, UND
1456 - 2322, MIT

Site Observations: GF (6 m/s) 2025 (11/356), MCO
MB (13 m/s) 2209 (05/355), MCO ✓†
GF (7 m/s) 2212 (09/355), MCO
GF (7 m/s) 2251 (05/033), MCO

Dual Doppler Times: 1939 - 2138 UND/TDWR*
2139 - 2200 MIT/UND
2305 - 2312 MIT/TDWR

*Scanning < 9° for UND, 2114 - 2131.

RHI Scans: MIT
1500 - 1534, NE/E/SE/S/SW
1534 - 1642, E
1642 - 1748, W/SW/S/SE
1751 - 1752, SE
1805 - 2008, N/NE/NW/W
2030 - 2131, NE

ASR-WSP data: 2020 – 2103
2208 – 2219

Sounding Times: 1153, 1449, 1750, 2045

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

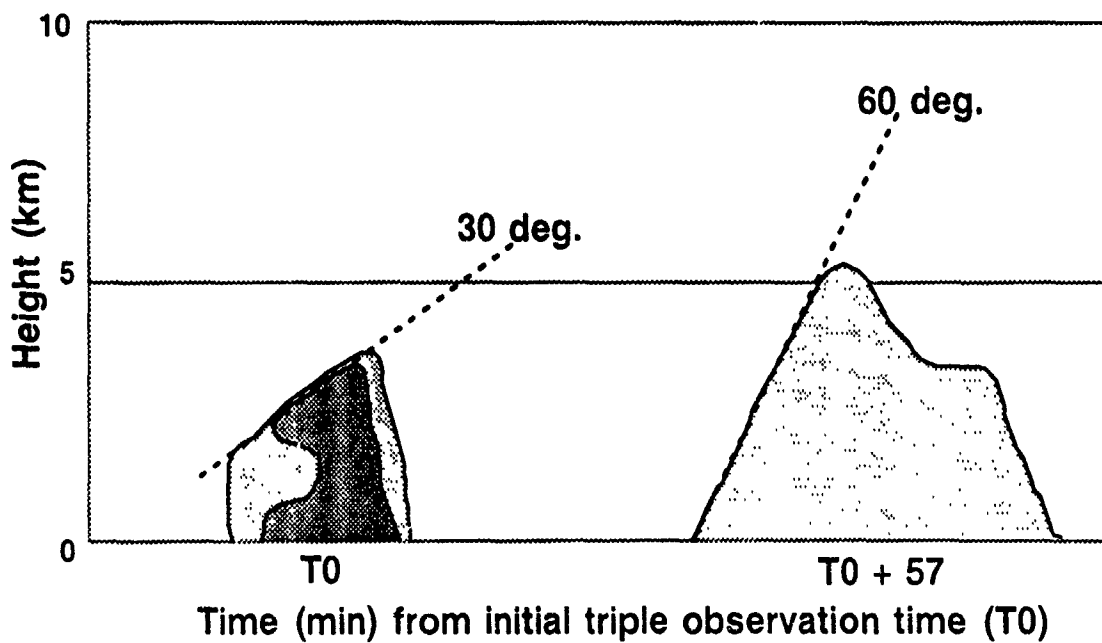
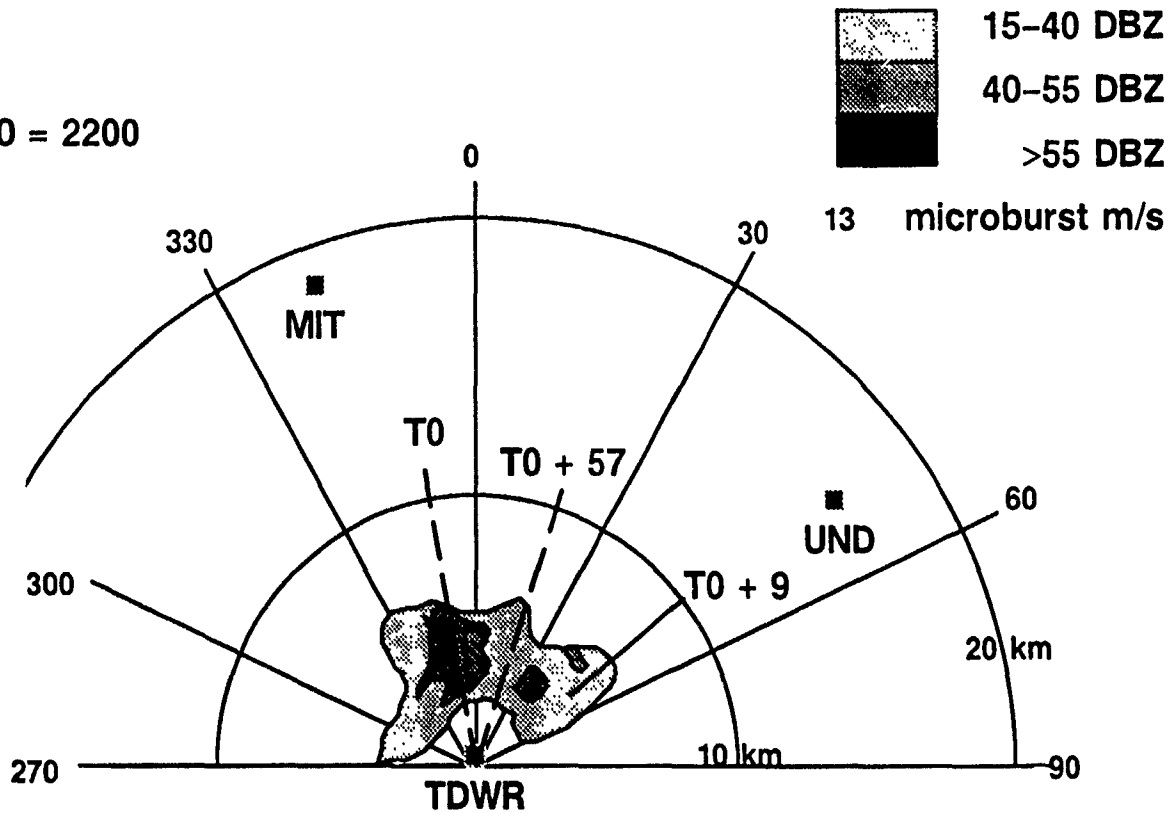
AWOS data: Yes

Interferometer data: None

Corona point data: 2200 – 2305
Stations C6, C3, C14, C24

22 JUNE 91

T0 = 2200



23 JUNE 91

Description: A strong, high reflectivity gust front originating from old thunderstorms moved from the SE to the NW across the triple Doppler region. One new cell formed behind the gust front to the SE of the center of the triple Doppler region and moved to the NW. It moved into the triple Doppler region slowly and as it did so, new cells formed nearby. These merged to form a large complex that continued to move NW. The sounding taken at 2040 GMT showed light west-northwesterly winds below the freezing level (4.8 km), and strong west-southwesterly winds above. The surface temperature was 30.7°C, the dew point was 19.8°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the edge of the first cell at $T_0 + 30$ min, just beginning to move into the triple Doppler region, and its position at $T_0 + 65$ min along with a new cell to its S.

Triple Doppler Times: 2252 - 0032 MIT/UND/TDWR

Total Coverage Times: 1528 - 0045, TDWR
2031 - 0032, UND
1547 - 0036, MIT

Site Observations: MB (18 m/s) 2037 (17/020), MCO
GF (6 m/s) 2108 (10/000), MCO
GF (6 m/s) 2257 (07/006), MCO
MB (17 m/s) 2357 (08/031), MCO ✓†
MB (15 m/s) 0009 (10/015)

Dual Doppler Times: 0032 - 0036 MIT/TDWR, over airport
2031 - 2252 UND/TDWR*

*Scanning < 9° for UND between 2116 - 2215

RHI Scans: MIT
1555 - 1642, full 360 with 20 degree increments
1642 - 1712, W/NW
1712 - 1718, NE
1718 - 1726, NE/W
1728 - 2026, SW/W/NW
2106 - 2249 E,SE

ASR-WSP data: 2029 - 2055
2210 - 2226
2231 - 2314
2318 - 0001
0003 - 0032

Sounding Times: 1155, 1449, 1747, 2040

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

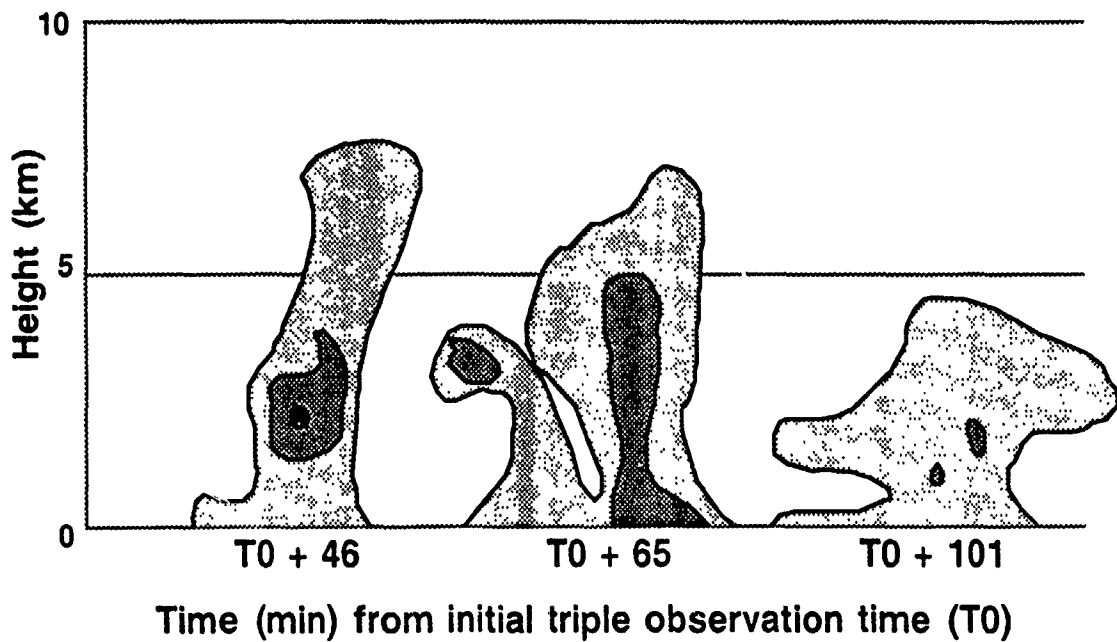
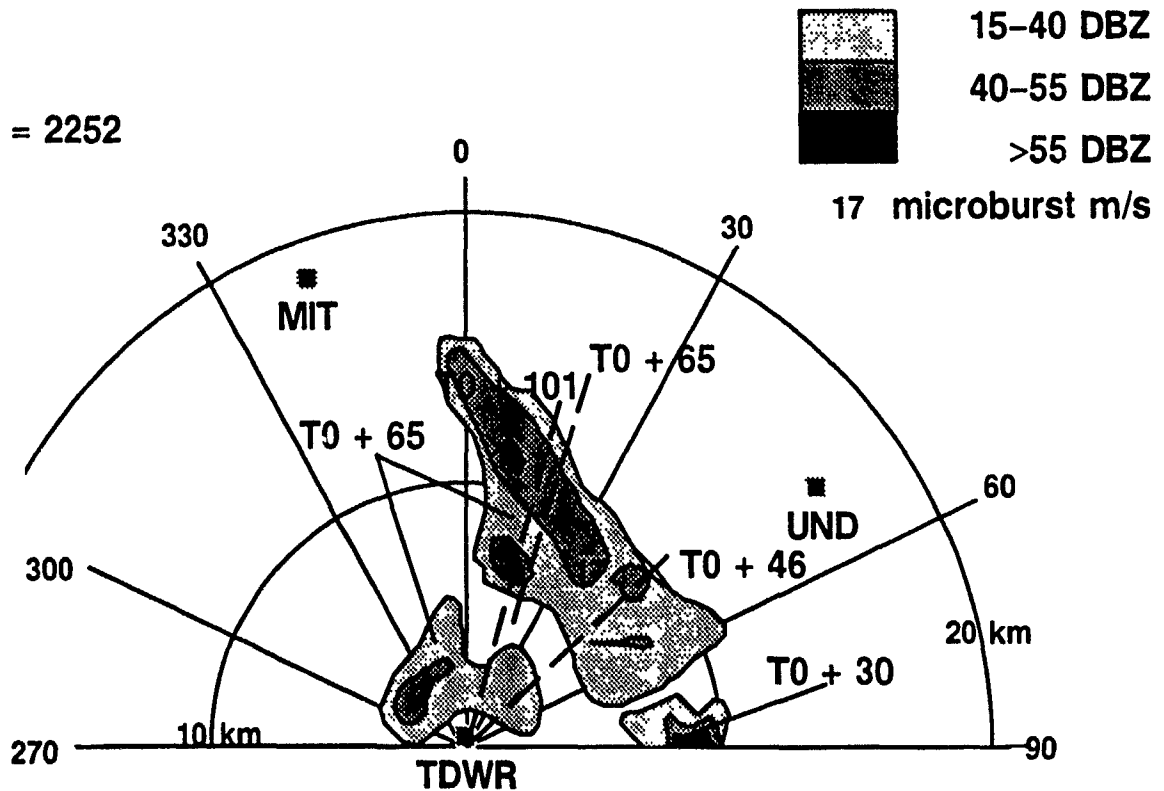
AWOS data: Yes

Interferometer data: None

Corona point data: 2252 - 0032
Stations C6, C3, C14, C24

23 JUNE 91

T0 = 2252



24 JUNE 91

Description: A gust front from an old thunderstorm passed through the triple Doppler region triggering the development of two small cells. These showers dissipated quickly and neither produced a microburst-strength outflow. There were no microbursts observed during the triple coverage on this day. The sounding taken at 2042 GMT showed moderate easterly flow at the surface, light northerly winds to 7 km, and moderate southwesterly winds above. The surface temperature was 26.1°C, the dew point was 21.3°C, the freezing level was 4.7 km, and the lifted condensation level was 0.4 km.

The accompanying sketch shows the passage of the gust front through the triple Doppler region, and the two showers triggered by its passage. The RHI shows the maximum vertical extent of the two showers.

Triple Doppler Times: 1922 - 1934 MIT/UND/TDWR

Total Coverage Times: 1529 - 2259, TDWR
1900 - 2100, UND
1634 - 2253, MIT

Site Observations: GF (8 m/s) 1909 (15/025), MCO †
(shown in sketch at 1928)

Dual Doppler Times: 1934 - 2100 UND/TDWR

RHI Scans: MIT
1639 - 1708, W/NW
1708 - 1820, NE/E
1820 - 1904, NW
1904 - 1920, NE/E
2126 - 2238, W
2238 - 2249, NE
UND
1914 - 1916, 1919 - 1920, NE

ASR-WSP data: 1849 - 1903
1916 - 2000
2002 - 2044

Sounding Times: 1155, 1445, 1754, 2042

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

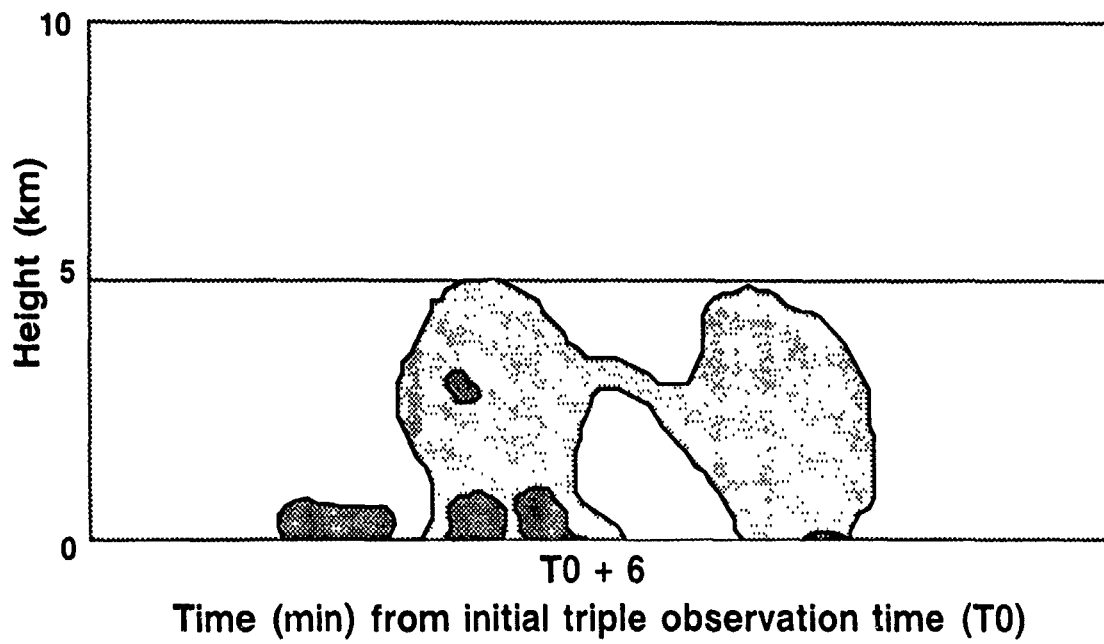
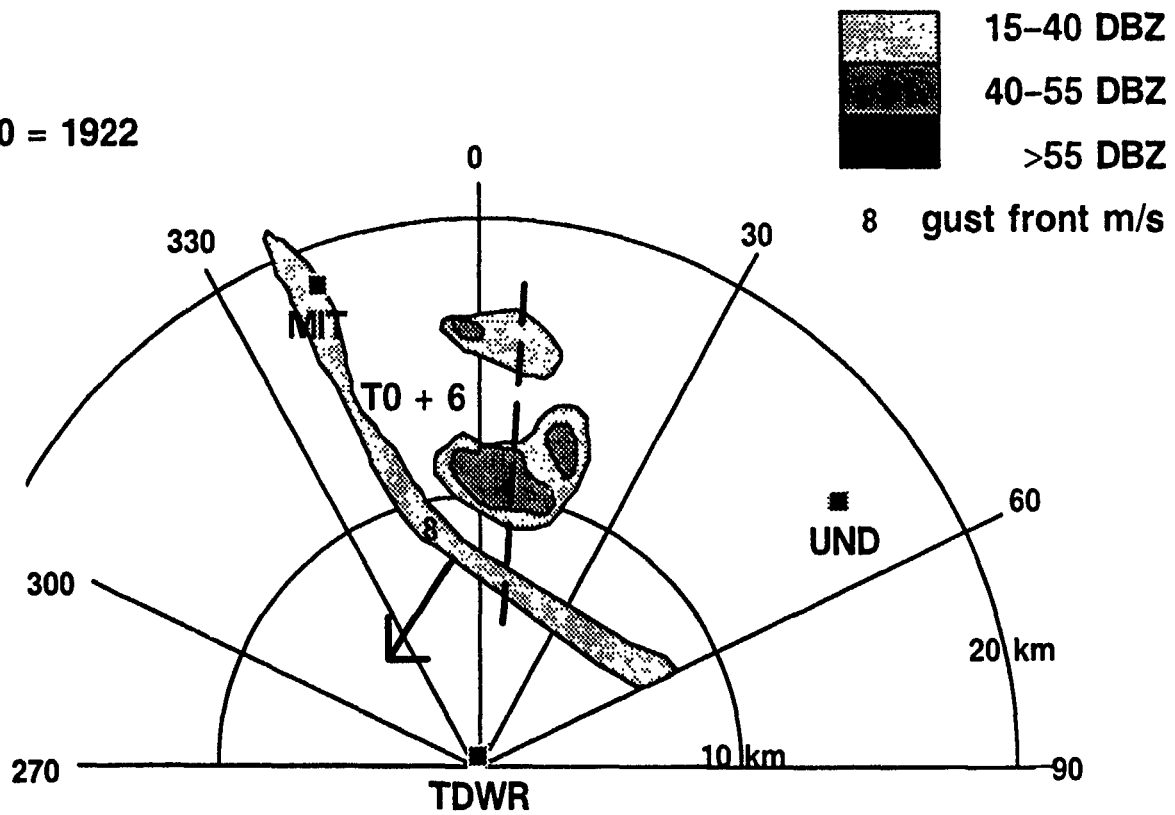
AWOS data: Yes

Interferometer data: None

Corona point data: 1934 - 2100
Stations C6, C3, C14, C24

24 JUNE 91

T0 = 1922



25 JUNE 91

Description: A gust front passed from N to S across the triple Doppler region, followed by a disorganized line of thunderstorms. New cells formed ahead of the line, and merged with it, producing a large complex that moved southward over the TDWR testbed. The sounding taken at 1744 GMT showed light and variable winds from the surface to 1 km, and moderate, variable winds to 16 km. The surface temperature was 30.7°C, the dew point was 19.5°C, the freezing level was 4.9 km, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the line of thunderstorms merged with the new cells moving southward over the triple Doppler region, and dissipating as it exits the region. The RHI set shows the presence of multiple cores in the complex.

Triple Doppler Times: 1743 - 2037 MIT/UND/TDWR

Total Coverage Times: 1527 - 2238, TDWR
1743 - 2037, UND
1502 - 2136, MIT

Site Observations: GF (10 m/s) 1838 (11/009), MCO
MB (10 m/s) 1921 (11/353), MCO
MB (14 m/s) 1923 (05/326), MCO
MB (21 m/s) 1935 (04/342), MCO ✓†

Dual Doppler Times: 1724 - 1730, MIT/TDWR
1735 - 1740, MIT/TDWR
2037 - 2136 MIT/TDWR, over airport

RHI Scans: MIT
1507 - 1722, NE, full 360 with 20 degree increments
1734, NE
1740 - 1742, E

ASR-WSP data: 1832 - 1916
1919 - 2002

Sounding Times: 1159, 1447, 1744, 2045

Aircraft data: None

ACARS data: Yes

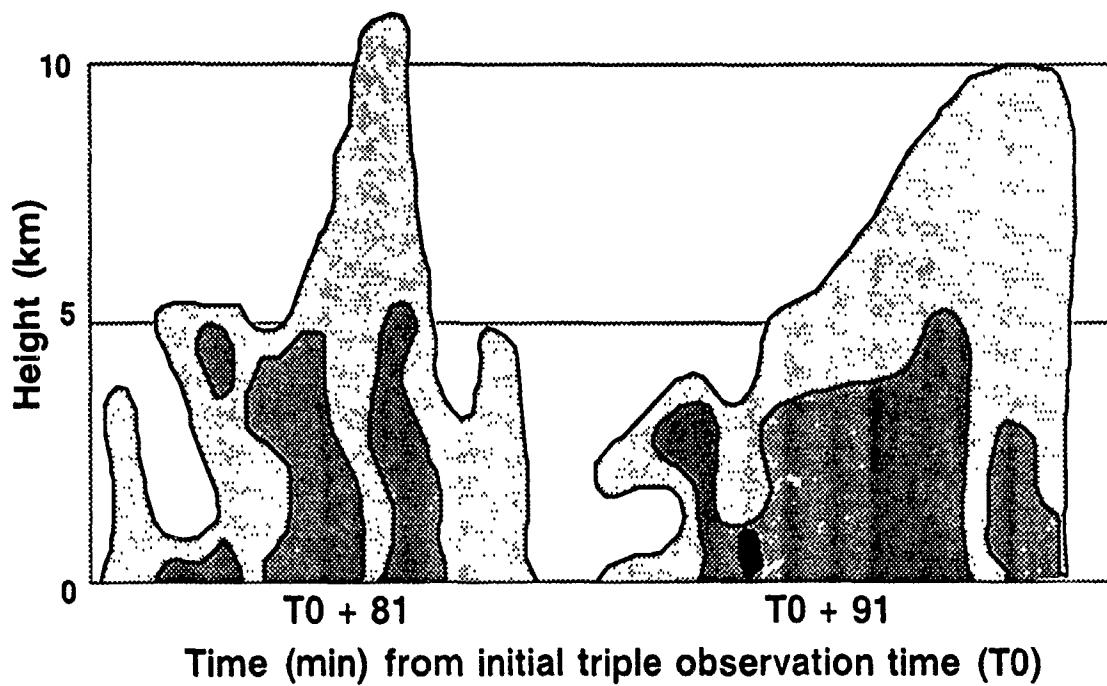
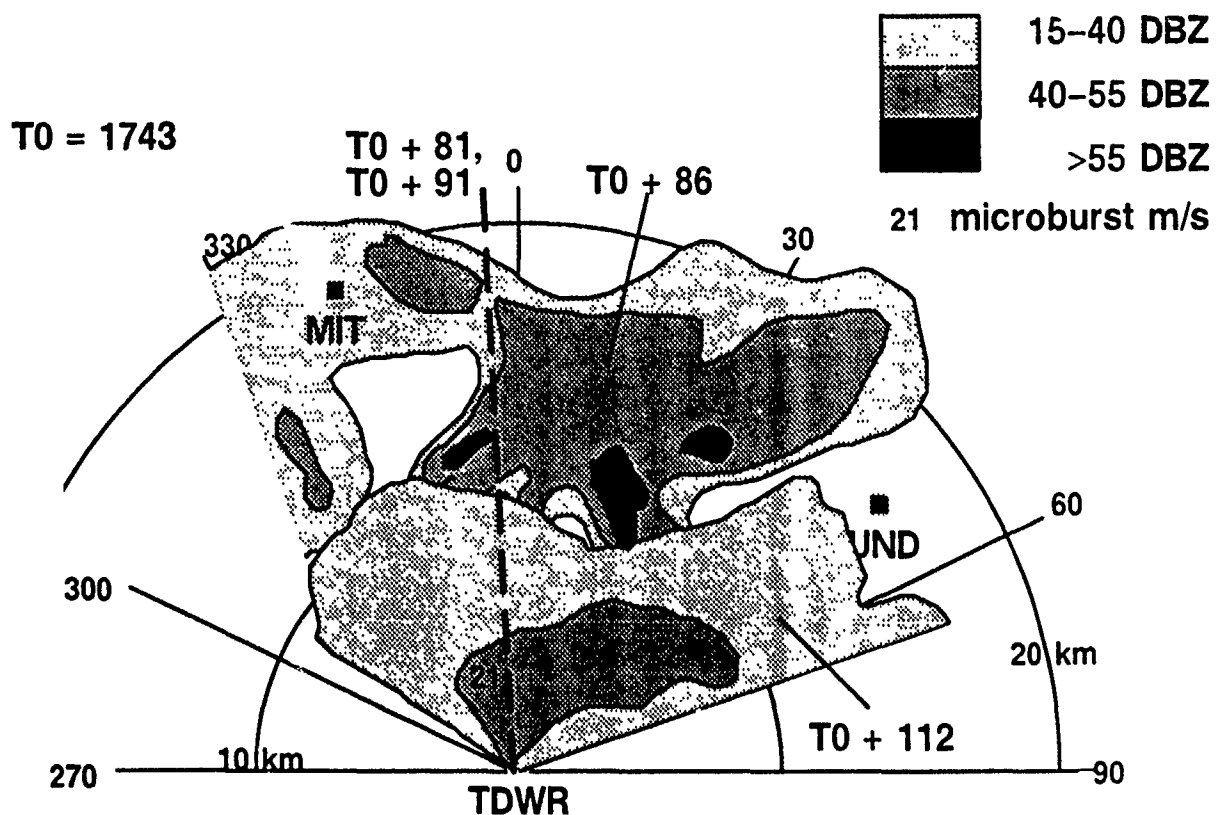
Mesonet and LLWAS data: None

AWOS data: Yes

Interferometer data: None

Corona point data: 1743 – 2037
Stations C6, C3, C7

25 JUNE 91



23 JULY 91

Description: A weak seabreeze front from the west coast passed through the triple Doppler region, triggering development of a single small shower on the edge to the region. No other development took place. The sounding taken at 1956 GMT showed light and variable winds below the freezing level (4.9 km), and increasingly stronger winds from the E above. The surface temperature was 32.0°C, the dew point was 20.8°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the passage of the gust front through the triple Doppler region and the shower that developed in its wake. The RHI shows the maximum vertical extent of the shower.

Triple Doppler Times: 2127 - 2304 MIT/UND/TDWR

Site Observations: GF (6 m/s) 2117 (15/004), MCO †
(shown in the sketch at 2132)

Total Coverage Times: 1958 - 2334, TDWR
2000 - 2333, UND
2014 - 2326, MIT

Dual Doppler Times: 2000 - 2127, MIT/TDWR
2304 - 2326 MIT/TDWR

RHI Scans: MIT
2017 - 2100 SW
UND
2317 - 2318, NW/N/S
2323 - 2324, SE
2328 - 2329, N

ASR-WSP data: 2040 - 2047
2107 - 2145

Sounding Times: 1130, 1356, 1703, 1956

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

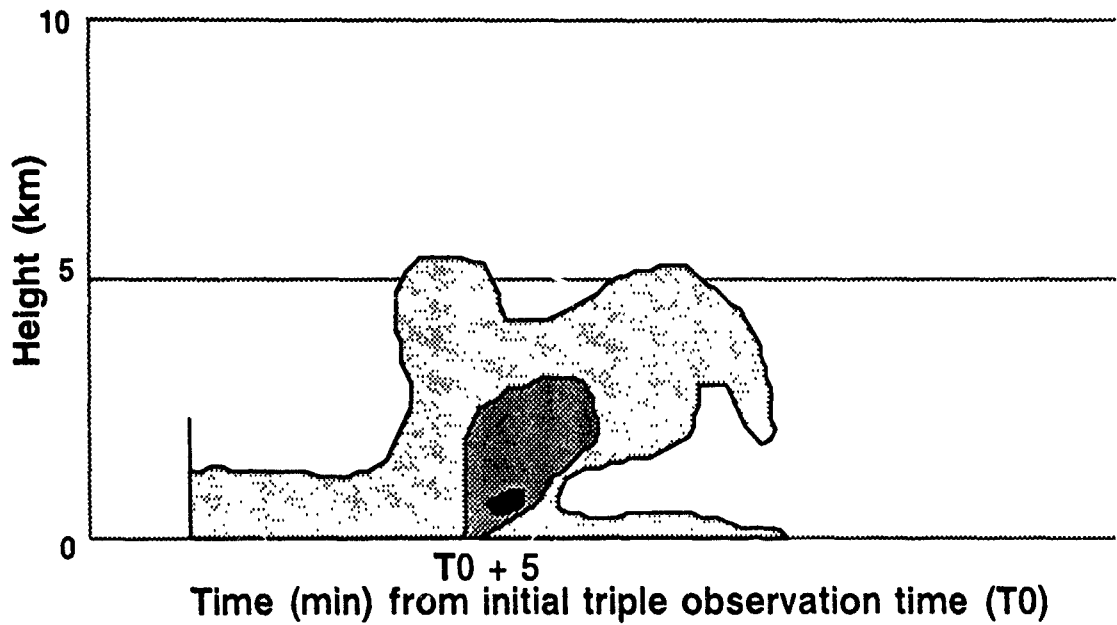
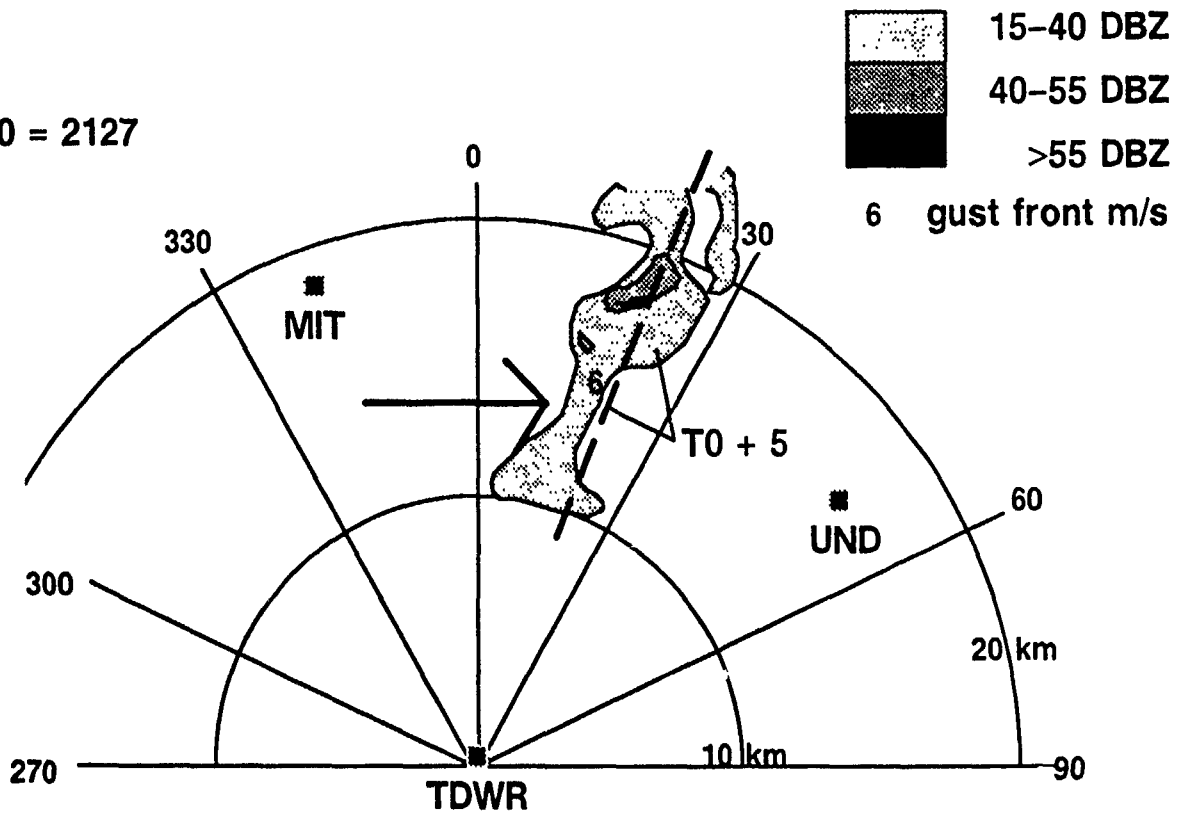
AWOS data: Yes

Interferometer data: None

Corona point data: 2127 - 2304
Stations C35, C39, C24

23 JULY 91

T0 = 2127



28 JULY 91

Description: In the early part of the triple time period, a small airmass thunderstorm quickly grew and dissipated, producing a microburst of 14 m/s. Later in the triple time period, a group of closely spaced thunderstorms moved in from the S and merged, forming a large, disorganized region of precipitation. One weak microburst was produced by this complex as it dissipated. The sounding taken at 1946 GMT showed light south-southwesterly winds below the freezing level (4.9 km), and light and variable east-northeasterly winds above. The surface temperature was 30.3°C, the dew point was 20.2°C, and the lifted condensation level was 0.9 km.

The first accompanying sketch shows the earliest cell at $T_0 - 1$ min, the time of the maximum surface outflow. The second accompanying sketch shows the mass of thunderstorms after merging at $T_0 + 103$, and the resulting 12 m/s outflow.

Triple Doppler Times: 2234 - 0026 MIT/UND/TDWR

Total Coverage Times: 1929 - 0129, TDWR
2023 - 0102, UND
1944 - 0026, MIT

Site Observations: GF (12 m/s) 2222 (11/356), MCO
MB (14 m/s) 2233 (16/041), MCO ✓†
MB (10 m/s) 0008 (06/356), MCO
MB (12 m/s) 0017 (10/349), MCO ✓†
MB (12 m/s) 0023 (13/353), MCO
MB (11 m/s) 0124 (15/032)

Dual Doppler Times: 2214 - 2234 UND/TDWR
0026 - 0051 UND/TDWR

RHI Scans: MIT
1946 - 2018, SE
2018 - 2216, SW/W/NW
UND
2029 - 2030, SE
2033 - 2035, 2039 - 2042, E
2045 - 2047, SE
0051, 0053 - 0054, NW
TDWR
2000 - 2359, intermittent between volume scans

ASR-WSP data: 2155 – 2214
2224 – 2239
2256 – 2307
2326 – 2330
2339 – 0020
0022 – 0039

Sounding Times: 1119, 1344, 1645, 1946

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 2234 – 0026

Station	1	92%	16	78%
	2	92%	17	76%
	3	70%	18	78%
	4	91%	19	78%
	5	0%	20	76%
	6	0%	21	78%
	7	0%	22	78%
	8	0%	23	78%
	9	0%	24	0%
	10	0%	25	74%
	11	0%	26	74%
	12	0%	27	74%
	13	93%	28	74%
	14	0%	29	74%
	15	0%	30	74%

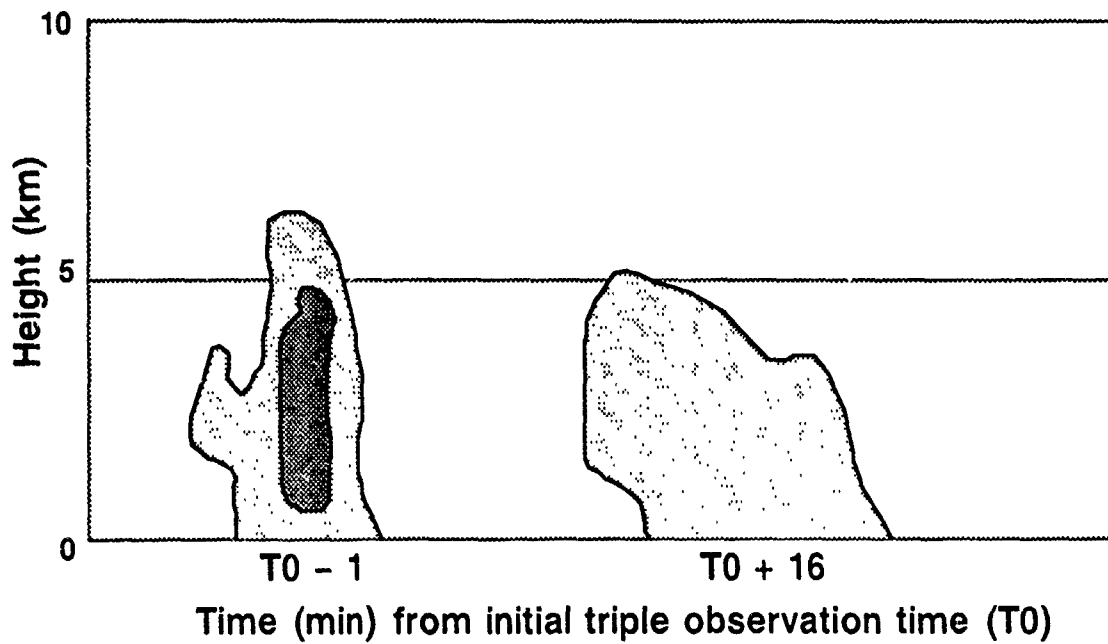
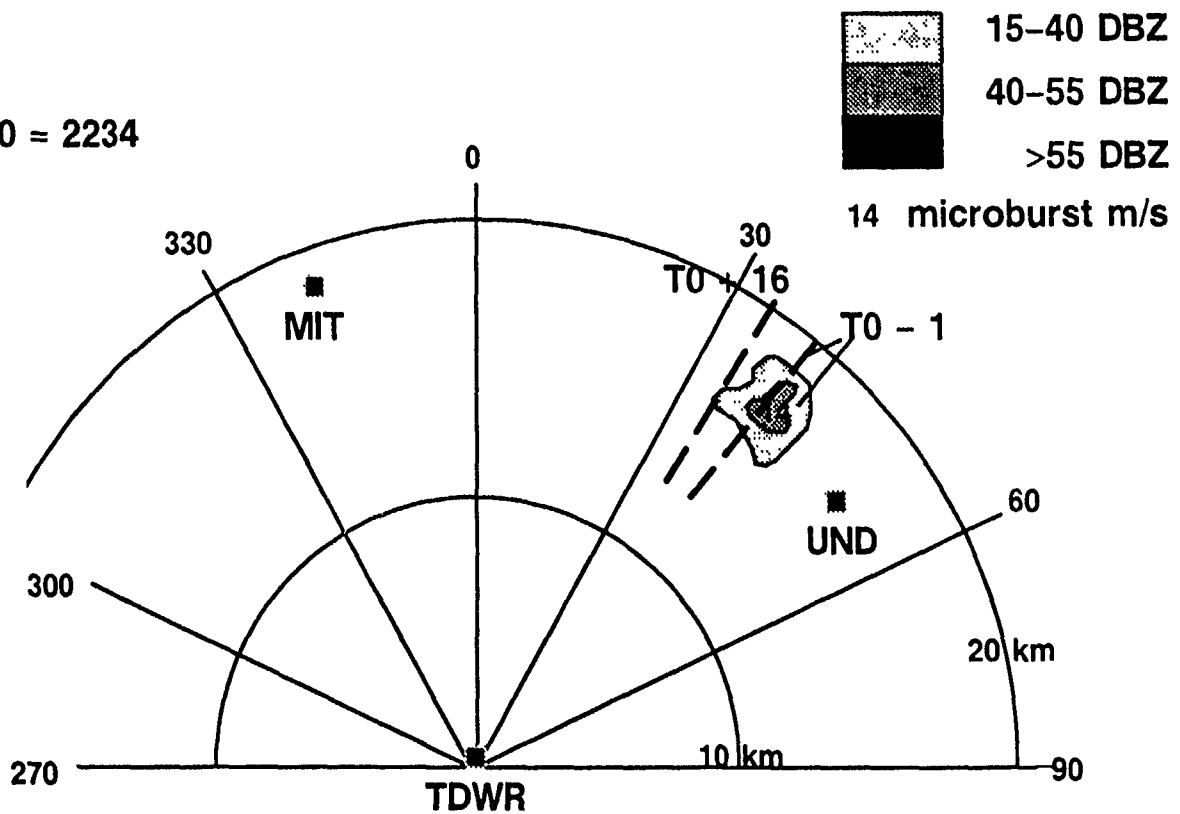
AWOS data: Yes

Interferometer data: None

Corona point data: None

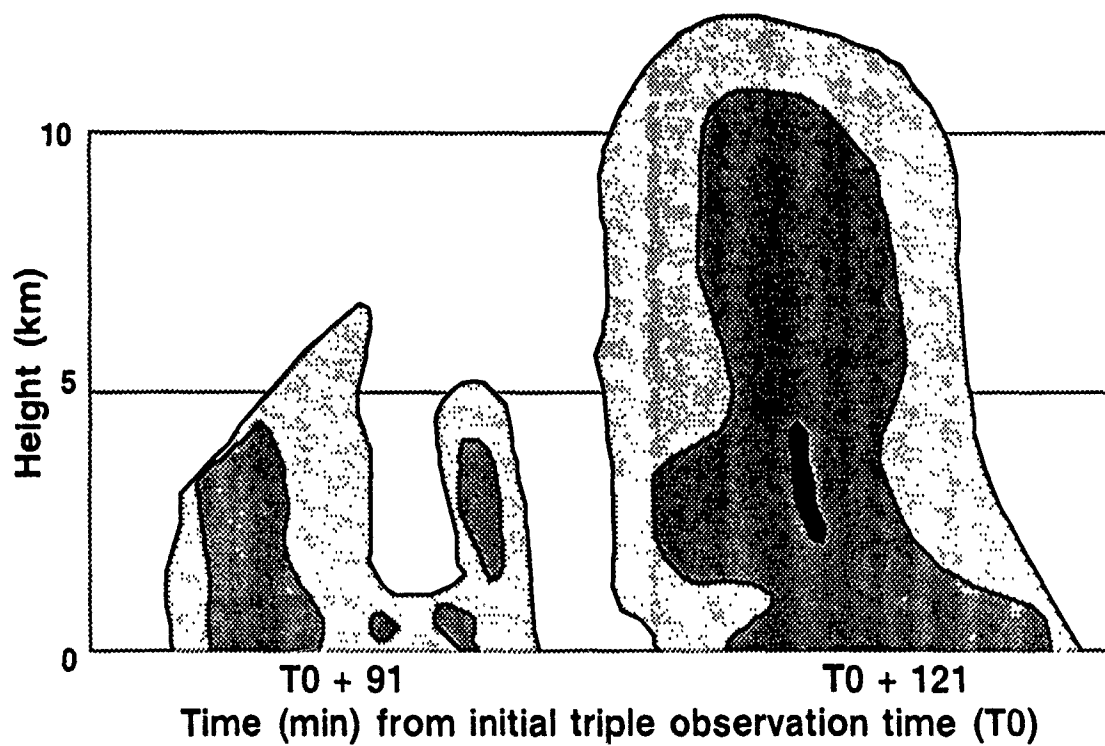
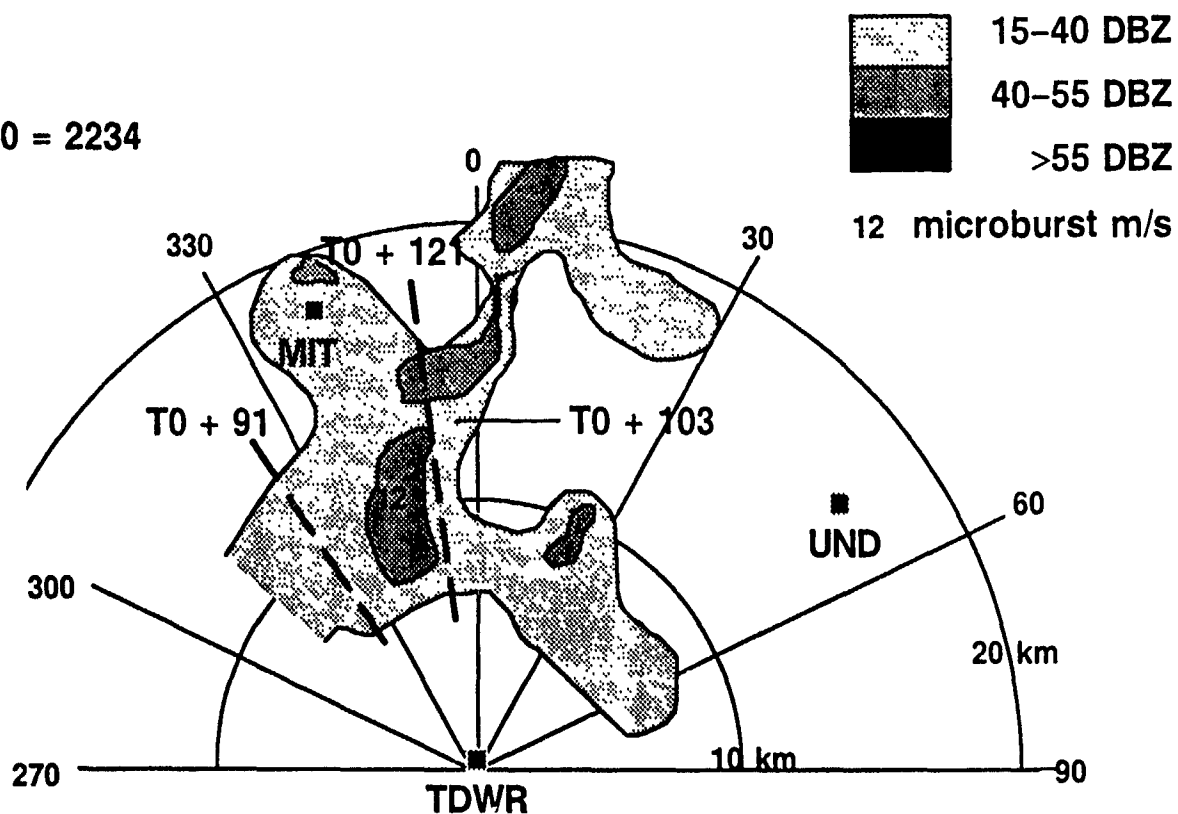
28 JULY 91

T0 = 2234



28 JULY 91

T0 = 2234



29 JULY 91

Description: Two large regions of showers and thunderstorms moved from the SW to the NE through the triple Doppler region. One region produced a weak microburst, while the other produced a 30 m/s microburst. One new cell formed in the region during the triple time period, but it did not produce a microburst-strength outflow. The sounding taken at 2002 GMT showed moderate southerly winds below the freezing level (4.9 km), and light and variable winds above. (Note : The sounding taken went only to 7.5 km.) The surface temperature was 31.6°C, the dew point was 19.9°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the two regions of precipitation, one S of the MIT radar and the other to the SW of the UND radar, moving into the triple Doppler region at $T_0 + 5$ min. The sketch also shows the developing cell to the NE of the TDWR testbed. The area of precipitation 20 km to the NE of the TDWR testbed remained outside of the triple Doppler region.

Triple Doppler Times: 2349 – 0047 MIT/UND/TDWR

Total Coverage Times: 1803 – 0049, TDWR
2101 – 0047, UND
1632 – 0111, MIT

Site Observations: GF (6 m/s) 2339 (06/044), MCO
MB (33 m/s) 2347 (10/313), MCO ✓† (shown in the sketch at 2354)

Dual Doppler Times: 2325 – 2349 UND/TDWR

RHI Scans: MIT
1632 – 1731, NE/N
1732 – 1907, NW/N
1908 – 2001, W/NW/N/NE
202 – 2029, SE/S/SW
UND
2104 – 2131, NE, intermittent between volume scans
2259 – 2317, SW, intermittent between volume scans
TDWR
2121 – 2134, intermittent between volume scans

ASR-WSP data: 2056 – 2108
2328 – 2344
2353 – 0031

Sounding Times: 1350, 1654, 2002

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 2349 – 0047

Station	1	91%	16	83%
	2	92%	17	90%
	3	0%	18	38%
	4	93%	19	95%
	5	0%	20	79%
	6	0%	21	95%
	7	0%	22	95%
	8	0%	23	95%
	9	0%	24	0%
	10	77%	25	95%
	11	0%	26	95%
	12	0%	27	95%
	13	94%	28	95%
	14	0%	29	95%
	15	0%	30	95%

AWOS data: Yes

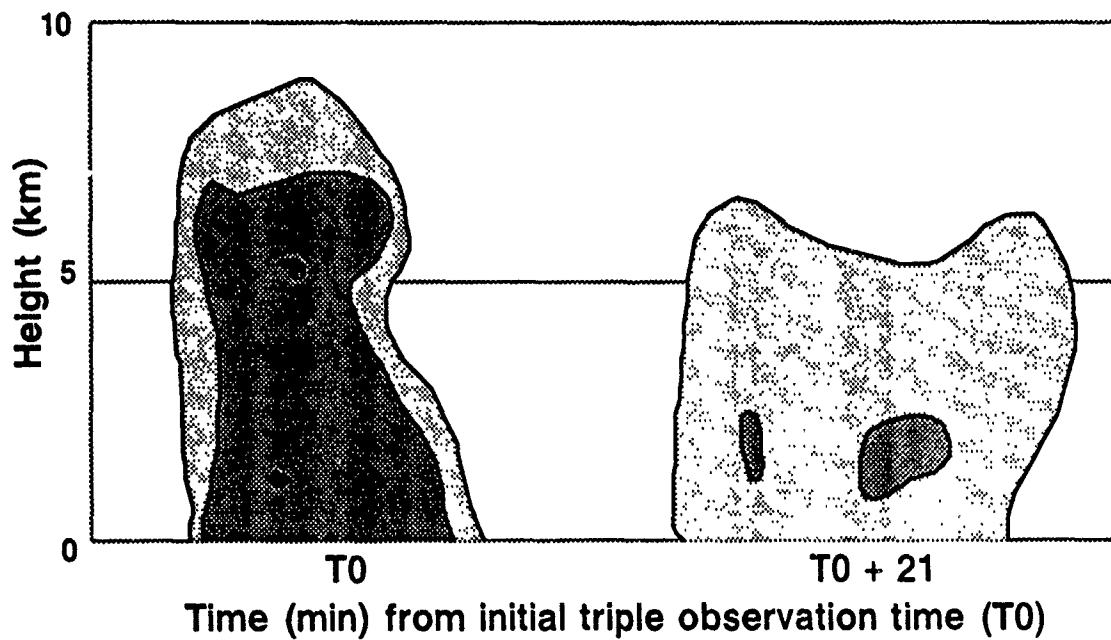
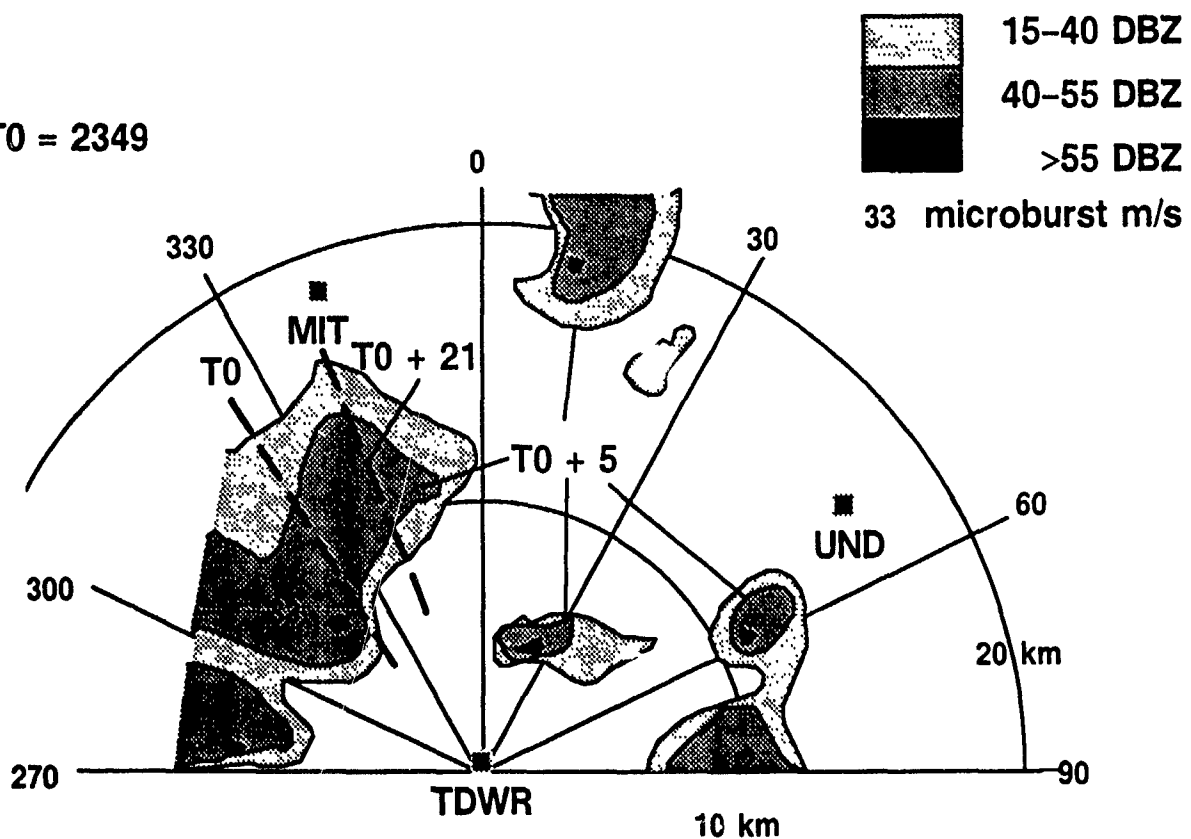
Interferometer data: None

Corona point data: 2349 – 0047

Stations C33, C32, C25, C14, C3, C22, C6, C1

29 JULY 91

T0 = 2349



31 JULY 91

Description: Two thunderstorms moved into the triple Doppler region from the S. One moved out of the region and dissipated; the other produced a weak microburst on the edge of the region and then dissipated. One new cell developed on the MIT-UND baseline, but quickly moved out of the triple region. The sounding taken at 1659 GMT showed moderate south-southwesterly winds from the surface to 6 km, where the winds became light and variable to 13 km. The surface temperature was 28.7°C, the dew point was 22.9°C, the freezing level was 5.1 km, and the lifted condensation level was 0.5 km.

The accompanying sketch shows the two cells that moved into the triple Doppler region from the S. The cells are shown at $T_0 + 5$ min, shortly before they began to dissipate.

Triple Doppler Times: 1746 – 1809 MIT/UND/TDWR

Total Coverage Times: 1604 – 2009, TDWR
1619 – 1854, UND
1537 – 2205, MIT

Site Observations: MB (11 m/s) 1740 (05/357), MCO ↗↑ (shown in the sketch at 1951)
GF (10 m/s) 1753 (12/100), MCO

Dual Doppler Times: 1648 – 1746 UND/TDWR

RHI Scans: MIT
1537 – 1725, SE/S/SW
1815 – 1852, S/SW/W/NW
1852 – 1923, SE/E/NE
1923 – 1932, W/NW
1932 – 1936, NE/E
1945 – 2054, NE/E/SE/S
2054 – 2205, W/NW
TDWR
1609 – 1610, 1615, 1620 – 1621, SE

ASR-WSP data: 1721 – 1728
1735 – 1805
1830 – 1832

Sounding Times: 1120, 1355, 1659

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 1746 - 1809

Station	1	92%	16	99%
	2	0%	17	99%
	3	91%	18	88%
	4	93%	19	100%
	5	0%	20	0%
	6	0%	21	100%
	7	0%	22	100%
	8	0%	23	100%
	9	0%	24	0%
	10	78%	25	91%
	11	0%	26	100%
	12	0%	27	100%
	13	94%	28	100%
	14	0%	29	100%
	15	0%	30	100%

AWOS data: Yes

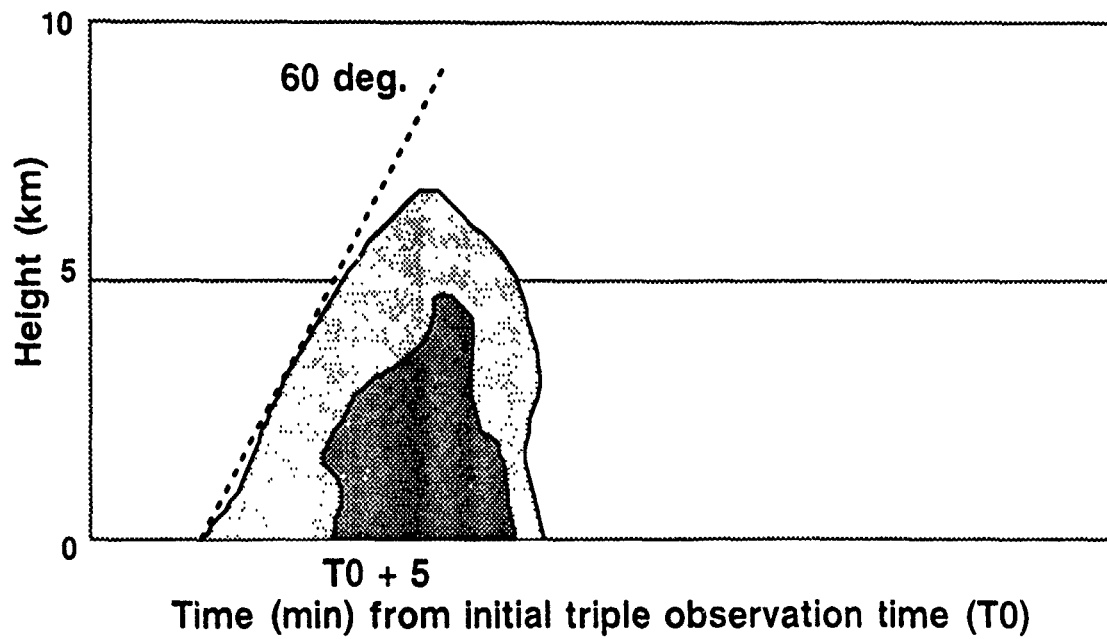
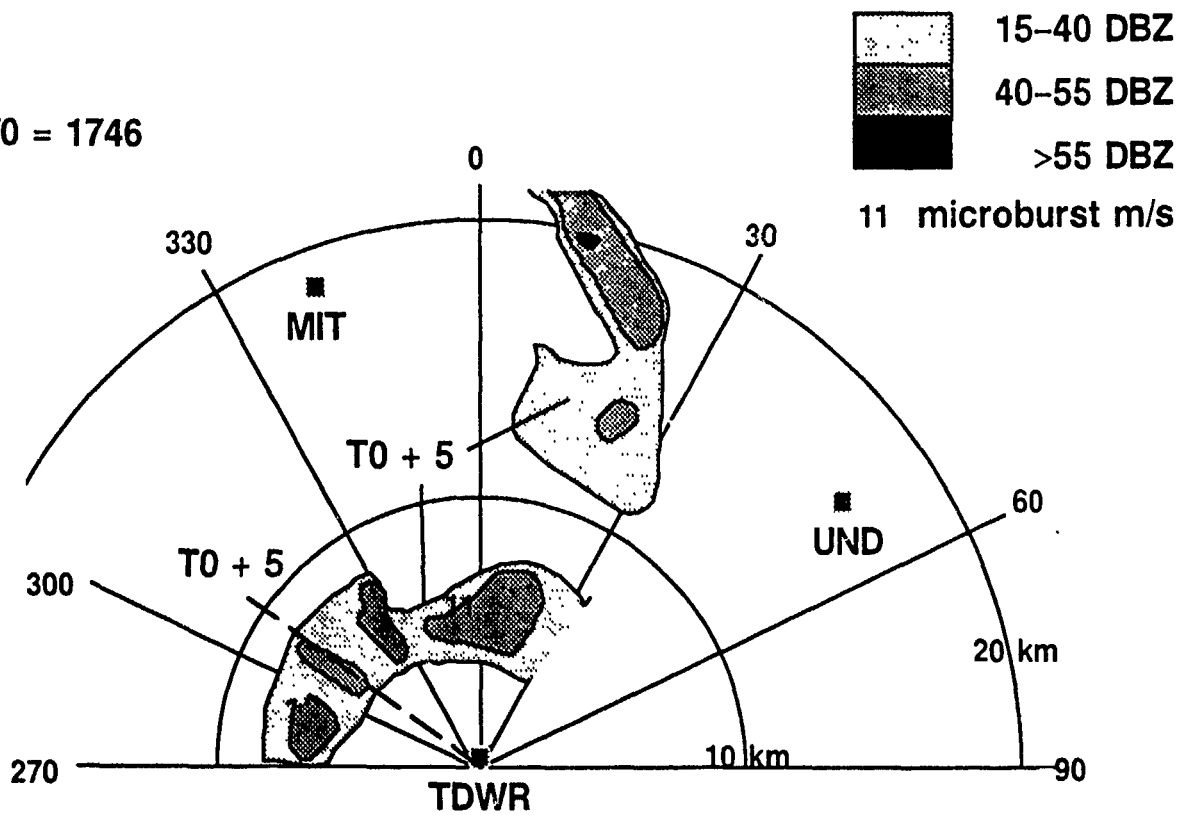
Interferometer data: None

Corona point data: 1746 - 1809

Stations C33, C32, C25, C14, C3, C6, C1

31 JULY 91

T0 = 1746



2 AUGUST 91

Description: A cluster of thunderstorms moved from the SW into the triple Doppler region, initiating new development ahead of the complex. The new cells merged with the complex, and continued the rapid movement to the NE. The system produced two moderate microbursts within the triple region. The sounding taken at 1953 GMT showed moderate southwesterly winds below the freezing level (4.9 km), with winds becoming increasingly stronger out of the ESE above. The surface temperature was 31.1°C, the dew point was 18.9°C, and the lifted condensation level was 1.1 km.

The accompanying sketch shows the complex as it moves into the triple Doppler region at $T_0 + 34$ min, merges with new cells and begins to exit the region at $T_0 + 63$ min.

Triple Doppler Times: 2027 - 2149 MIT/UND/TDWR

Total Coverage Times: 1841 - 2236, TDWR
2001 - 2331, UND
1742 - 0059, MIT

Site Observations: GF (8 m/s) 2056 (06/357), MCO
MB (14 m/s) 2107 (06/039), MCO
MB (14 m/s) 2116 (10/019), MCO ✓
MB (13 m/s) 2126 (15/020)
MB (17 m/s) 2130 (20/026), MCO ✓†
GF (8 m/s) 2253 (04/001), MCO

Dual Doppler Times: 1845 - 1903 MIT/TDWR
2001 - 2027 UND/TDWR

RHI Scans: MIT
1836 - 1843, SW
1912 - 2022, W
2152 - 2359, NE
UND
2151 - 2200, 2200 - 2202, 2244 - 2247, 2252 - 2255
2259 - 2302, 2307 - 2309, 2314 - 2317, 2321 - 2324
2328 - 2331, E/SE
TDWR
2044, 2220 - 2221, W/SW

ASR-WSP data: 2039 - 2051
2053 - 2131

Sounding Times: 1124, 1352, 1647, 1953

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 2027 – 2149

Station	1	93%	16	98%
	2	0%	17	97%
	3	92%	18	97%
	4	94%	19	98%
	5	0%	20	96%
	6	0%	21	98%
	7	0%	22	98%
	8	0%	23	93%
	9	0%	24	0%
	10	84%	25	0%
	11	0%	26	100%
	12	92%	27	100%
	13	92%	28	100%
	14	0%	29	100%
	15	0%	30	100%

AWOS data: Yes

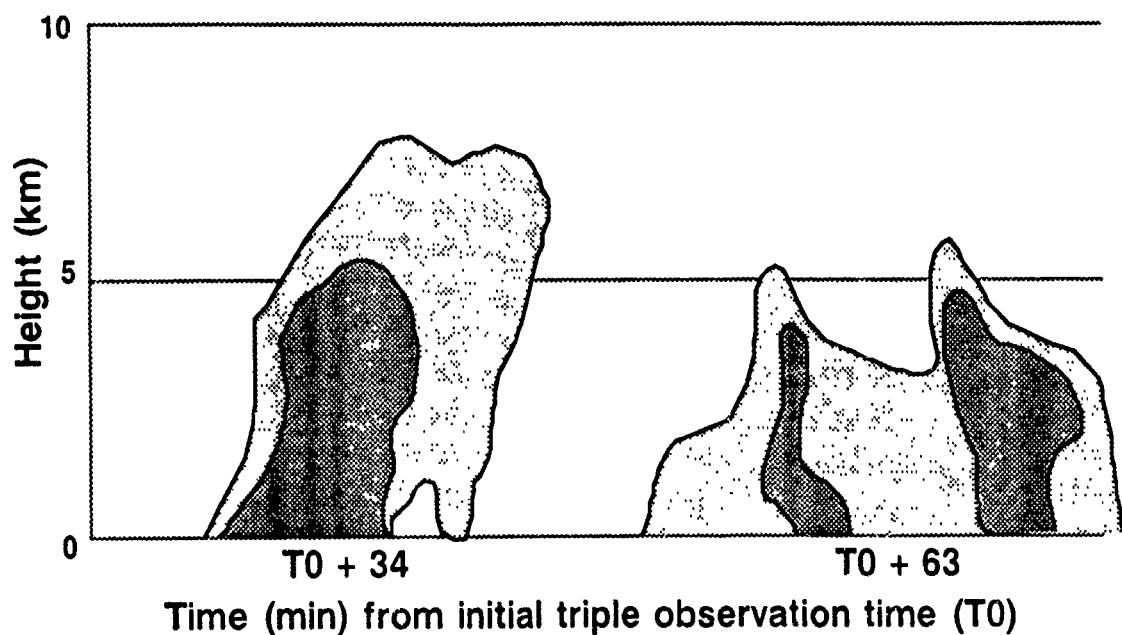
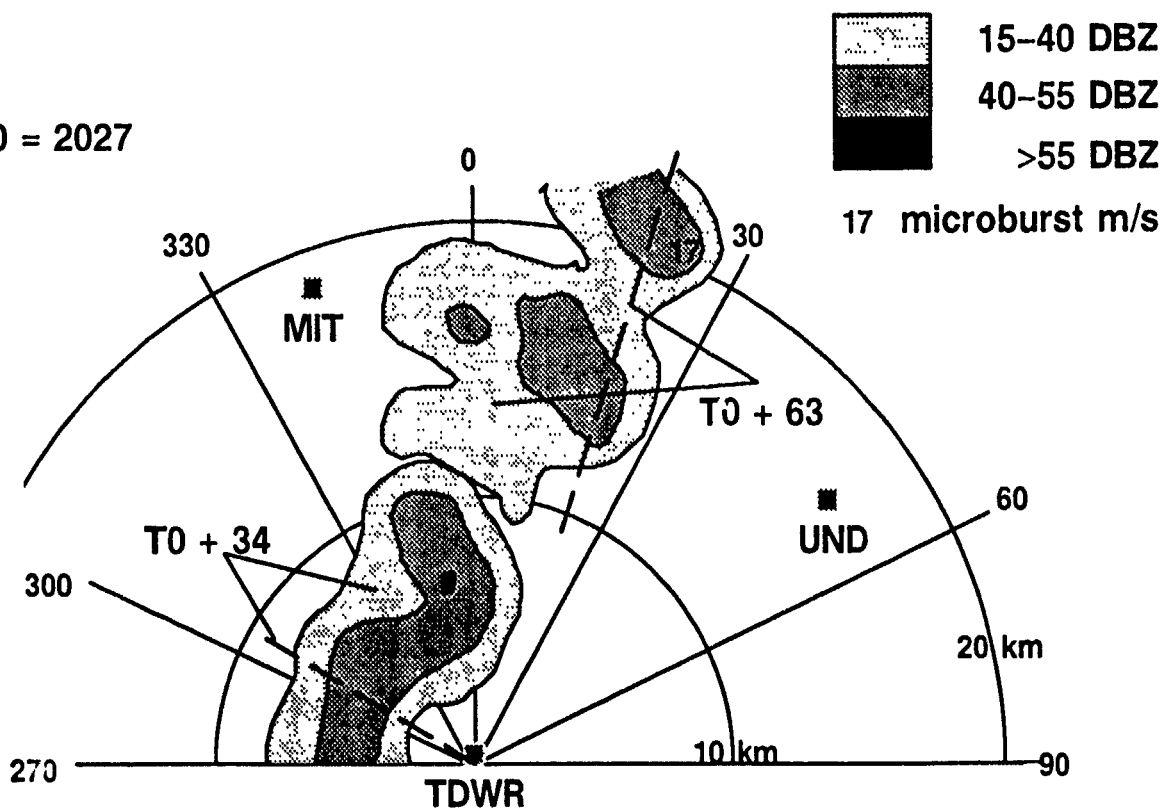
Interferometer data: None

Corona point data: 2027 – 2149

Stations C32, C25, C14, C3, C22, C6, C1

2 AUGUST 91

T0 = 2027



5 AUGUST 91

Description: A small airmass cell developed within the triple Doppler region and moved eastward. A second cell formed just to the north of the first, and the two cells merged. The multicell storm produced a microburst with a maximum differential velocity of 15 m/s. The sounding taken at 1657 GMT showed light and variable winds below the freezing level (4.7 km), and light to moderate northeasterly winds above. The surface temperature was 29.0°C, the dew point was 21.3°C, and the lifted condensation level was 0.7 km.

The accompanying sketch shows the initial cell at $T_0 + 9$ min, which merged with a second cell at $T_0 + 19$ min (not shown), and the complex at $T_0 + 26$ min.

Triple Doppler Times: 1605 - 1704, 1729 - 1829 MIT/UND/TDWR

Total Coverage Times: 1450 - 1957, TDWR
1459 - 1850, UND
1535 - 2141, MIT

Site Observations: MB (12 m/s) 1528 (06/346), MCO
GF (6 m/s) 1750 (13/005), MCO
MB (14 m/s) 1755 (14/037) ✓†
MB (11 m/s) 1803 (14/041)

Dual Doppler Times: 1459 - 1605, UND/TDWR
1704 - 1729 UND/TDWR

RHI Scans: MIT
1545 - 1604, SW
1831 - 2135, NE/E/SE/SW
TDWR
1559 - 1835, intermittent between volume scans

ASR-WSP data: 1715 - 1737
1739 - 1805

Sounding Times: 1118, 1358, 1657, 1946

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data:

1605 – 1704

Station	1	94%	16	100%
	2	0%	17	97%
	3	92%	18	95%
	4	0%	19	100%
	5	0%	20	99%
	6	0%	21	100%
	7	0%	22	100%
	8	0%	23	100%
	9	0%	24	0%
	10	87%	25	100%
	11	0%	26	100%
	12	92%	27	100%
	13	85%	28	100%
	14	0%	29	100%
	15	0%	30	100%

1729 – 1829

Station	1	93%	16	92%
	2	0%	17	89%
	3	92%	18	89%
	4	0%	19	91%
	5	0%	20	90%
	6	0%	21	91%
	7	0%	22	90%
	8	0%	23	91%
	9	0%	24	0%
	10	88%	25	100%
	11	0%	26	100%
	12	93%	27	100%
	13	94%	28	100%
	14	0%	29	100%
	15	0%	30	100%

AWOS data: Yes**Interferometer data:** None

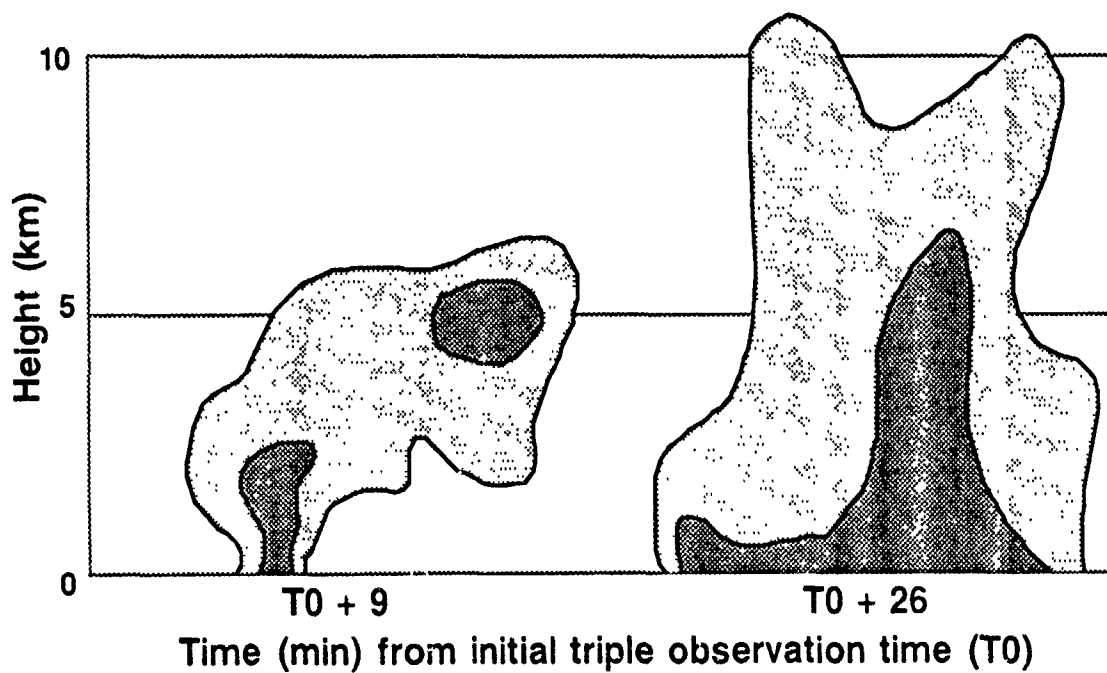
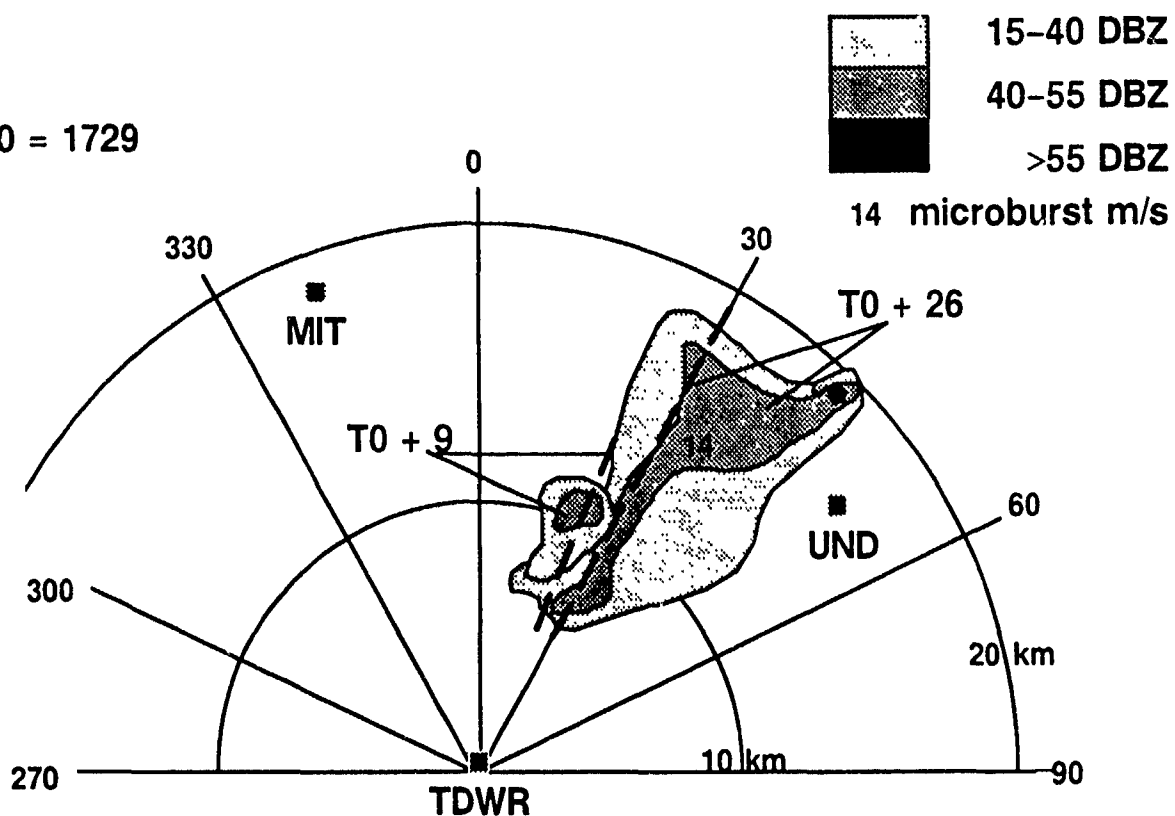
Corona point data: 1605 – 1704
None

1729 - 1829

Stations C32, C25, C24, C33, C3, C22, C6

5 AUGUST 91

T0 = 1729



9 AUGUST 91

Description: A southeastward moving gust front at the leading edge of an old thunderstorm outflow triggered a new, rapidly growing cell in the triple Doppler region. The storm merged with other newly developed, rapidly growing cells over the airport to form a large multicell storm. The entire storm complex drifted slowly from NW to SE. The strongest surface outflow of the entire data collection period was observed (45 m/s). The sounding taken at 1935 GMT showed northwesterly winds below the freezing level (4.9 km), and light and variable winds above. The surface temperature was 32°C, the dew point was 20.1°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the initial surface cell at $T_0 - 9$ min developing into the main multicell storm at $T_0 + 22$ min. The RHI at $T_0 + 15$ min reveals multiple cells. This storm produced the 45 m/s outflow at $T_0 + 31$ min (not shown). The storm is shown in the dissipating stage at $T_0 + 51$ min.

Triple Doppler Times: 1912 - 1918 MIT/UND/TDWR
1923 - 2038

Total Coverage Times: 1701 - 2313, TDWR
1815 - 2311, UND
1850 - 2250, MIT

Site Observations: GF (10 m/s) 1909 (08/357), MCO
MB (40 m/s) 1931 (12/353), MCO ✓
MB (21 m/s) 1931 (11/338)
MB (45 m/s) 1943 (08/017), MCO ✓† (shown in the sketch at 1934)
MB (21 m/s) 1944 (05/020), MCO ✓
MB (16 m/s) 1945 (09/019), MCO ✓
MB (31 m/s) 1947 (06/011), MCO ✓
MB (18 m/s) 1947 (29/060), MCO
MB (27 m/s) 1951 (05/059) ✓
MB (30 m/s) 1958 (07/049) ✓
MB (30 m/s) 1959 (09/068) ✓
GF (9 m/s) 2214 (07/351), MCO

Dual Doppler Times: 1818 - 1912, UND/TDWR
1918 - 1923, UND/TDWR, over the airport

RHI Scans: MIT
1850 - 1912 W
1920 - 1923 SE,
2043 - 2250 E,NE

UND
 2308 – 2311 N
 TDWR
 1848 – 2244, intermittent between volume scans

ASR-WSP data: 1908 – 1950
 1951 – 2011

Sounding Times: 1138, 1408, 1645, 1935

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 1912 – 1918

Station	1	95%	16	100%
	2	0%	17	0%
	3	0%	18	100%
	4	0%	19	100%
	5	0%	20	100%
	6	0%	21	100%
	7	0%	22	100%
	8	0%	23	100%
	9	0%	24	0%
	10	92%	25	100%
	11	0%	26	100%
	12	89%	27	100%
	13	92%	28	100%
	14	0%	29	100%
	15	0%	30	100%

1923 – 2038

Station	1	93%	16	84%
	2	0%	17	0%
	3	0%	18	48%
	4	0%	19	93%
	5	0%	20	93%
	6	0%	21	93%
	7	0%	22	92%
	8	0%	23	93%
	9	0%	24	0%

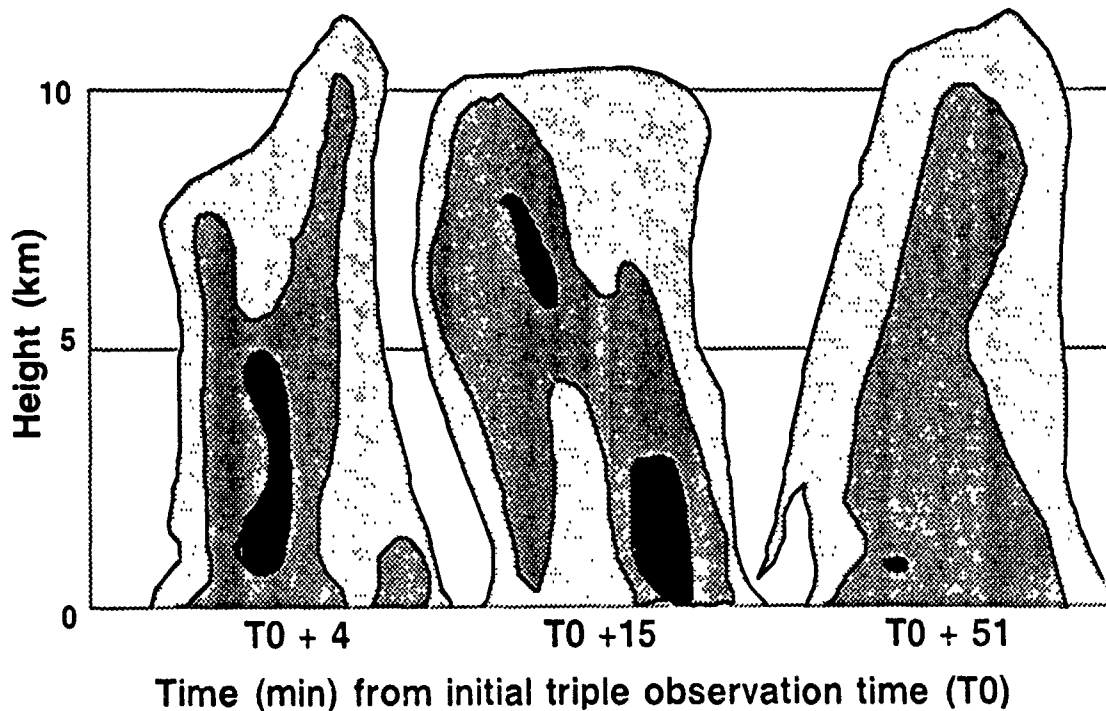
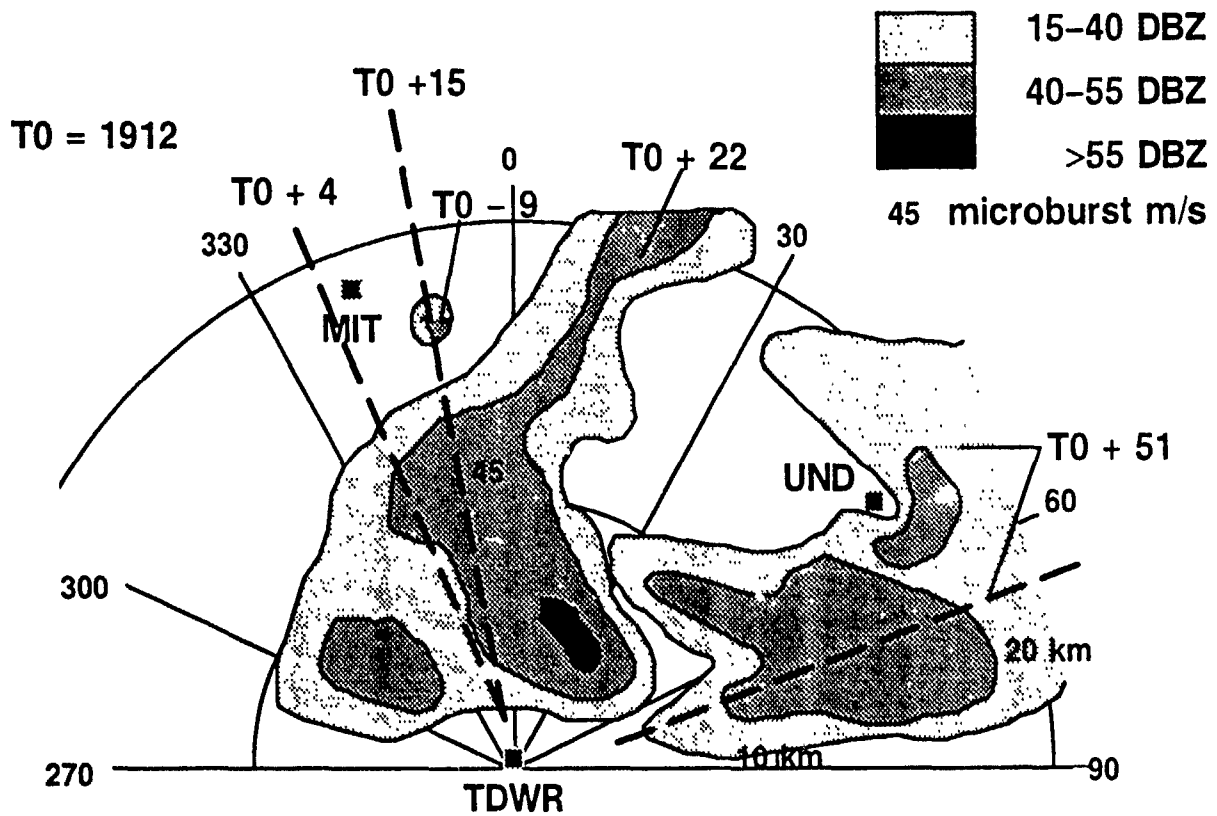
9	0%	24	0%
10	88%	25	100%
11	0%	26	100%
12	92%	27	100%
13	88%	28	100%
14	0%	29	100%
15	0%	30	100%

AWOS data: Yes

Interferometer data: None

Corona point data: 1912 - 1918
 Stations C3, C35, C6 (bad), C1
 1923 - 2038
 Stations C3, C22 (some bad), C35, C6 (some bad), C1

9 AUGUST 91



10 AUGUST 91

Description: A gust front passed through the triple Doppler region from W to E in advance of a large thunderstorm. Behind the gust front new cells developed; a few merged with the older thunderstorm moving E, another formed a second large thunderstorm to the S of the first. They began to dissipate after exiting the triple Doppler region, while new cells continued to develop behind the gust front in advance of the dissipating cells. The sounding taken at 1943 GMT showed light to moderate west-southwesterly winds below the freezing level (5.2 km), and light southeasterly winds above. The surface temperature was 31.9°C, the dew point was 20.7°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the initial thunderstorm moving into the triple region, and a new cell forming in advance of the larger cell at T_0 . As the pair moved to the E, they merged, and a second cell developed to the S at $T_0 + 28$ min.

Triple Doppler Times: 2033 - 2129 MIT/UND/TDWR
2211 - 2317

Total Coverage Times: 1512 - 2333, TDWR
1953 - 2322, UND
1709 - 0111, MIT

Site Observations: MB (22 m/s) 2050 (21/350), MCO
GF (7 m/s) 2053 (12/054), MCO
MB (16 m/s) 2059 (11/024), MCO ✓
MB (32 m/s) 2101 (14/015) ✓†
MB (20 m/s) 2105 (13/028) ✓
MB (17 m/s) 2111 (16/029) ✓
MB (14 m/s) 2114 (14/051) ✓
GF (7 m/s) 2221 (07/026), MCO
MB (24 m/s) 2223 (10/058)
MB (20 m/s) 2231 (04/016), MCO
MB (23 m/s) 2238 (07/040), MCO ✓
MB (23 m/s) 2244 (09/035)

Dual Doppler Times: 1953 - 2033 UND/TDWR

RHI Scans: MIT
1746 - 2023 W
2141 - 2211 SW,NE
2321 - 0111 E,NE
TDWR
1908 - 2302, intermittent between volume scans

ASR-WSP data: 2024 - 2049
 2050 - 2120
 2156 - 2210
 2212 - 2252

Sounding Times: 1120, 1344, 1654, 1943

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 2033 - 2129

Station	1	92%	16	88%
	2	0%	17	0%
	3	0%	18	68%
	4	0%	19	88%
	5	0%	20	86%
	6	0%	21	88%
	7	0%	22	88%
	8	0%	23	88%
	9	0%	24	0%
	10	86%	25	100%
	11	0%	26	100%
	12	92%	27	100%
	13	93%	28	100%
	14	0%	29	100%
	15	0%	30	100%

2111 - 2317

Station	1	92%	16	88%
	2	0%	17	0%
	3	0%	18	68%
	4	0%	19	88%
	5	0%	20	86%
	6	0%	21	88%
	7	0%	22	88%
	8	0%	23	88%
	9	0%	24	0%
	10	86%	25	100%
	11	0%	26	100%
	12	92%	27	100%

13	93%	28	100%
14	0%	29	100%
15	0%	30	100%

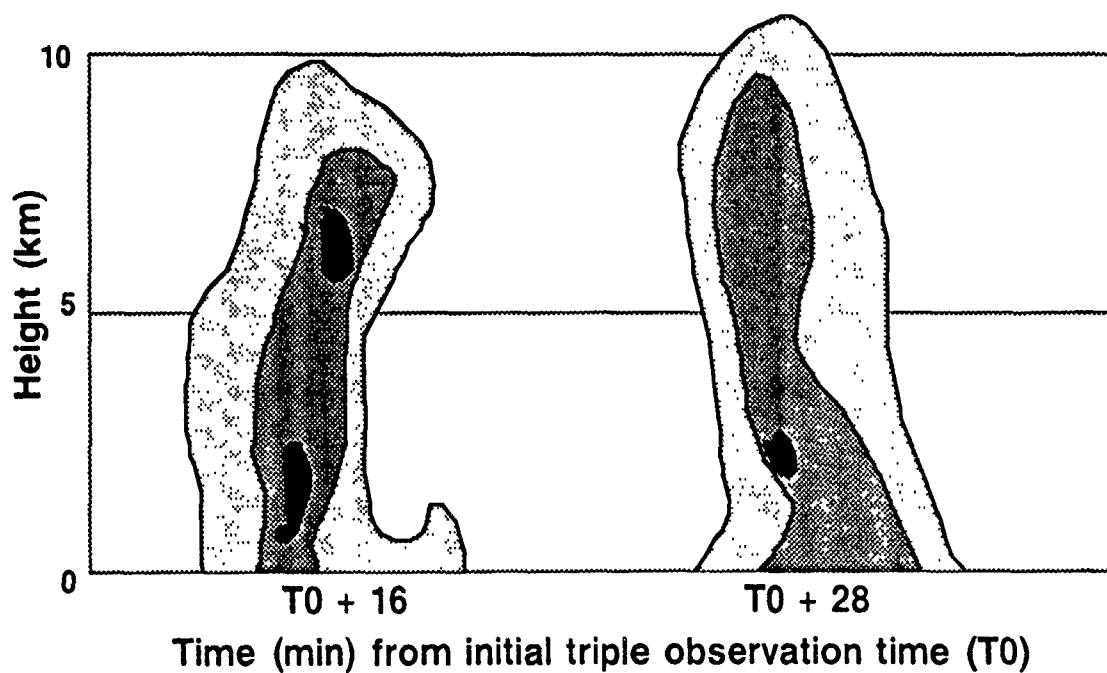
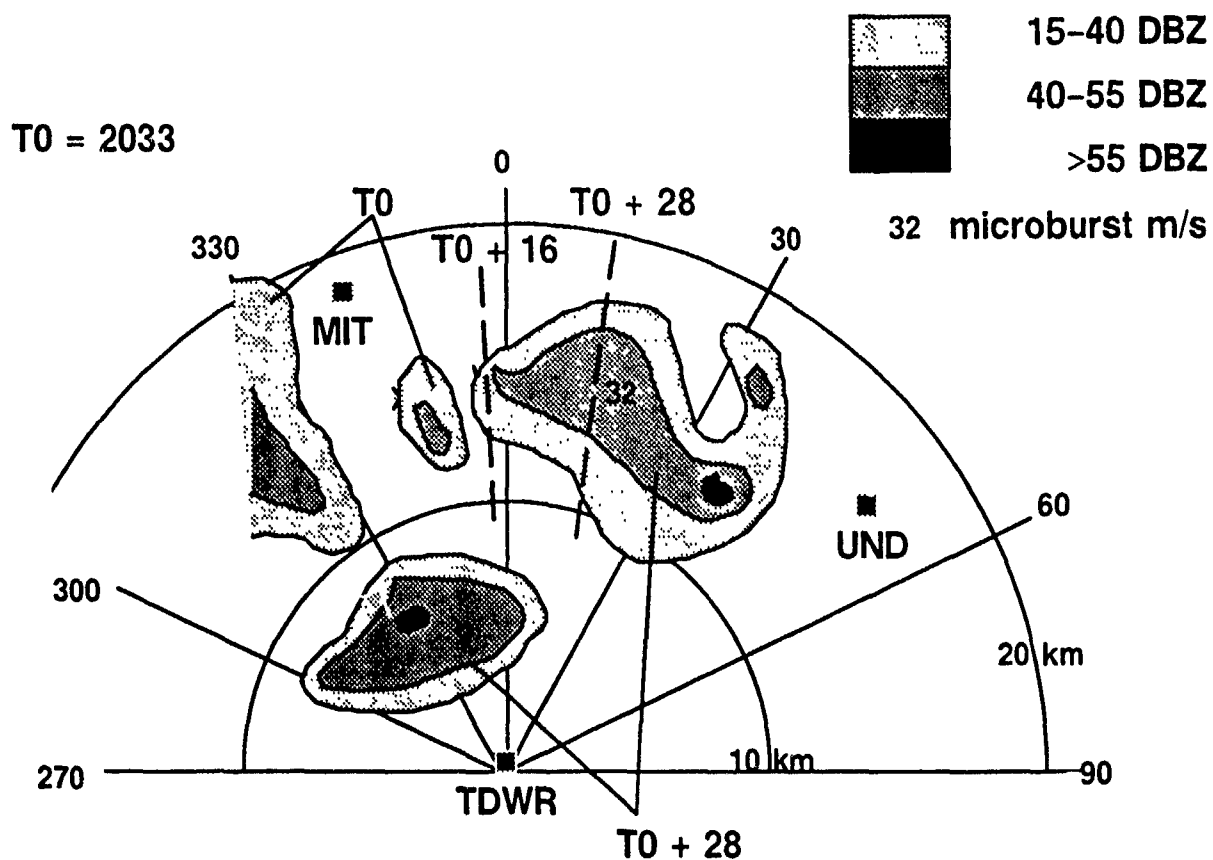
AWOS data: None

Interferometer data: None

Corona point data: 2033 - 2129

Stations C32, C24, C33, C3, C22 (some bad), C35, C6, C1

10 AUGUST 91



12 AUGUST 91

Description: A few isolated thunderstorms developed on this day, but only one formed within the triple Doppler region. The cell formed to the NE of the TDWR testbed, and moved to the NE while continuing to grow. It merged with the remains of another small cell, and the resultant cell produced an 18 m/s microburst. A second small thunderstorm formed to the W of this cell, but did not merge with it. The sounding taken at 1950 GMT showed light southwesterly winds below the freezing level (4.9 km), and light and variable winds above. The surface temperature was 31.2°C, the dew point was 19.8°C, and the lifted condensation level was 1.0 km.

The accompanying sketch shows the original position of the cell at $T_0 + 8$ min, and its position at $T_0 + 46$ min, after it merges with the remains of another cell. A second small cell present at the time is also shown.

Triple Doppler Times: 2207 - 2324 MIT/UND/TDWR

Total Coverage Times: 2106 - 2337, TDWR
2021 - 2340, UND
2012 - 0118, MIT

Site Observations: GF (5 m/s) 2143 (16/003), MCO
MB (17 m/s) 2253 (17/006), MCO ✓†
MB (12 m/s) 2301 (14/001), MCO

Dual Doppler Times: 2324 - 2337 UND/TDWR

RHI Scans: MIT
2017 - 2153, NW
0022 - 0118, SE/SW
TDWR
2140 - 2337, intermittent between volume scans

ASR-WSP data: 2251 - 2311

Sounding Times: 1117, 1428, 1648, 1950

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data:

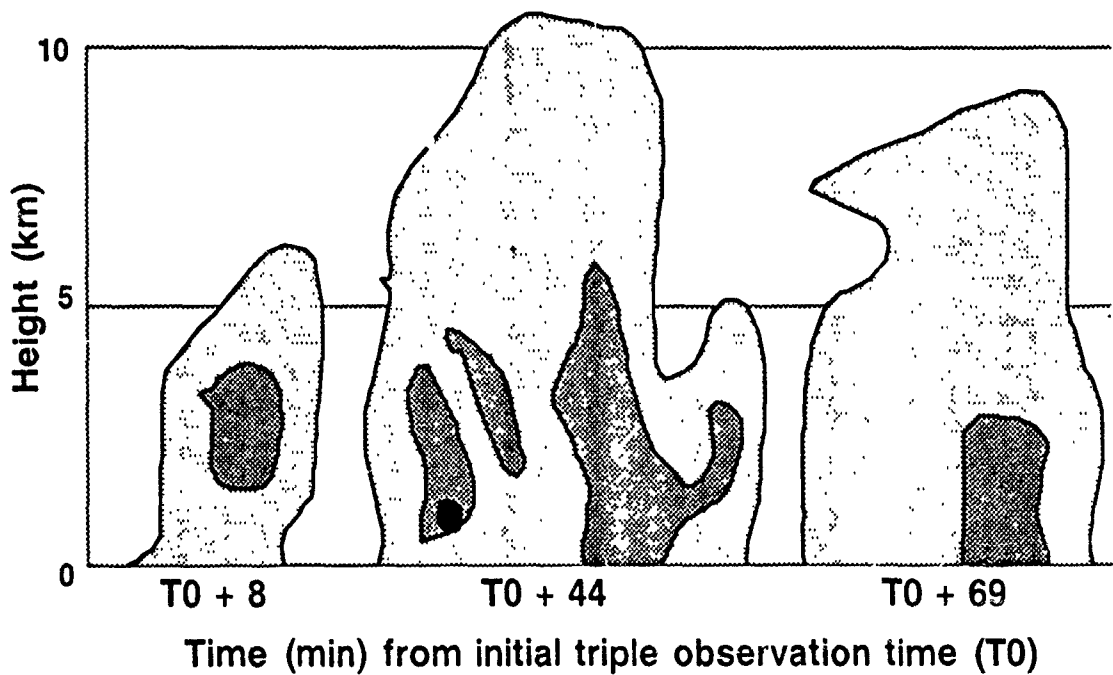
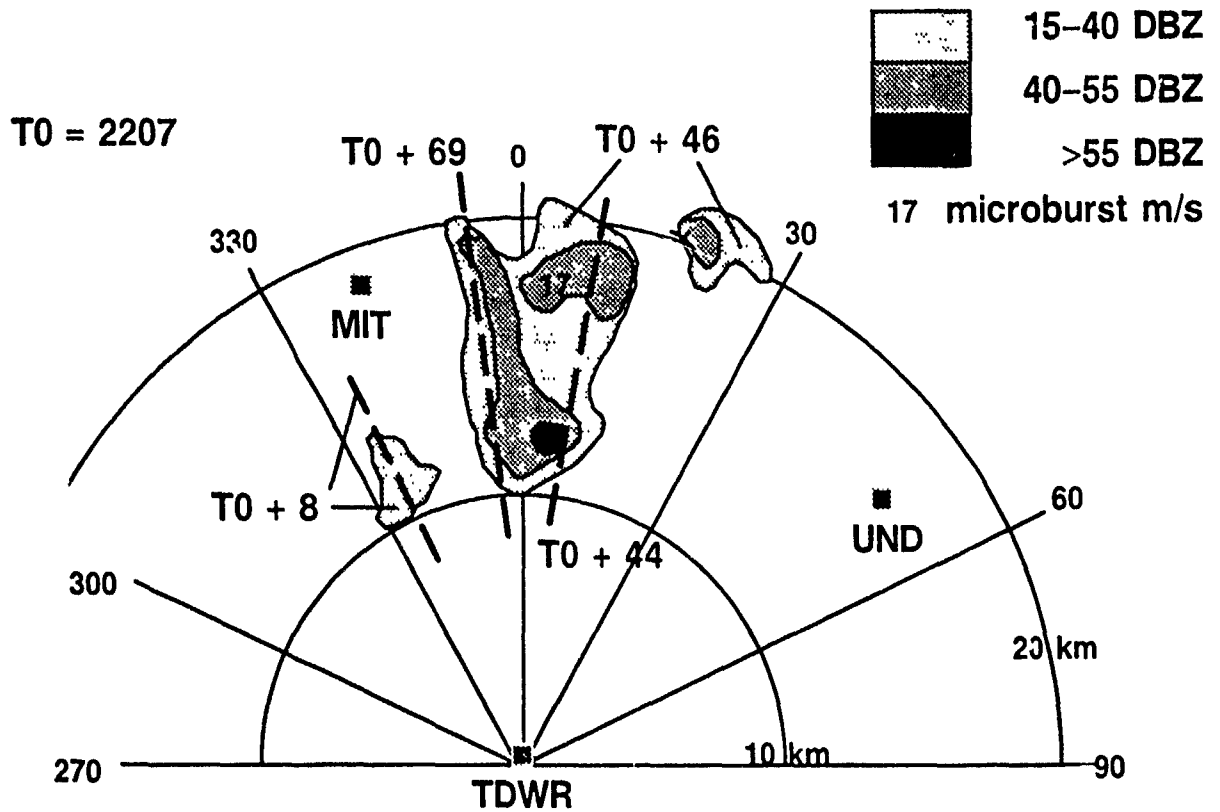
2207 - 2324

Station	1	92%	16	100%
	2	0%	17	0%
	3	0%	18	0%
	4	0%	19	100%
	5	0%	20	100%
	6	0%	21	100%
	7	0%	22	100%
	8	95%	23	100%
	9	0%	24	0%
	10	0%	25	99%
	11	0%	26	99%
	12	93%	27	99%
	13	0%	28	99%
	14	0%	29	99%
	15	0%	30	99%

AWOS data: Yes**Interferometer data:** None**Corona point data:** 2207 - 2324

Stations C33, C3, C22 (bad), C1

12 AUGUST 91



15 AUGUST 91

Description: A gust front moved into the triple Doppler region from the NW followed by a small cluster of thunderstorms. After passing into the triple sector, a burst of new development took place around the initial cells, forming a broad multicell line. Ahead of the line and over the airport, another cell developed which eventually merged with the line. The line then began to broaden; some parts grew and other parts dissipated. This process continued for 45 minutes, until most of the cells dissipated into stratiform rain. Two strong outflows were produced by this system, one 22 m/s and the other 28 m/s. Eventually this system produced an interesting feature: a long surface divergence line that remained for at least an hour. The sounding taken at 1939 GMT showed strong northwesterly winds at the surface, with light southeasterly winds above. The surface temperature was 26.5°C, the dew point was 17.8°C, the freezing level was 4.7 km, and the lifted condensation level was 0.8 km.

The accompanying sketch shows the multicell complex as it enters the triple Doppler region and the burst of development that is taking place. The system is shown at $T_0 + 63$ min, the time of maximum outflow. The system continues to expand after this time, and a part of it is shown at $T_0 + 98$ min.

Triple Doppler Times: 1849 – 2028 MIT/UND/TDWR

Total Coverage Times: 1728 – 2306, TDWR
1814 – 2042, UND
1704 – 2218, MIT

Site Observations: GF (6 m/s) 1830 (14/350), MCO
MB (24 m/s) 1851 (12/346), MCO
MB (12 m/s) 1904 (15/346)
MB (12 m/s) 1908 (13/351)
MB (19 m/s) 1920 (16/010)
MB (17 m/s) 1944 (07/349), MCO ✓
MB (12 m/s) 1948 (13/034) ✓
MB (22 m/s) 1952 (09/356), MCO ✓†
MB (21 m/s) 1952 (08/020), MCO ✓
MB (22 m/s) 2003 (09/030) ✓

Dual Doppler Times: 1816 – 1849 UND/TDWR

RHI Scans: MIT
1717 – 1843, W/NW/N
2030 – 2217, NE/E/SE

UND
1816, NW
TDWR
1825 - 2026, intermittent between volume scans
2206, 2212 - 2213, 2218 - 2219, 2225, E/NE

ASR-WSP data: 1846 - 1919
1920 - 2005

Sounding Times: 1111, 1401, 1656, 1939

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

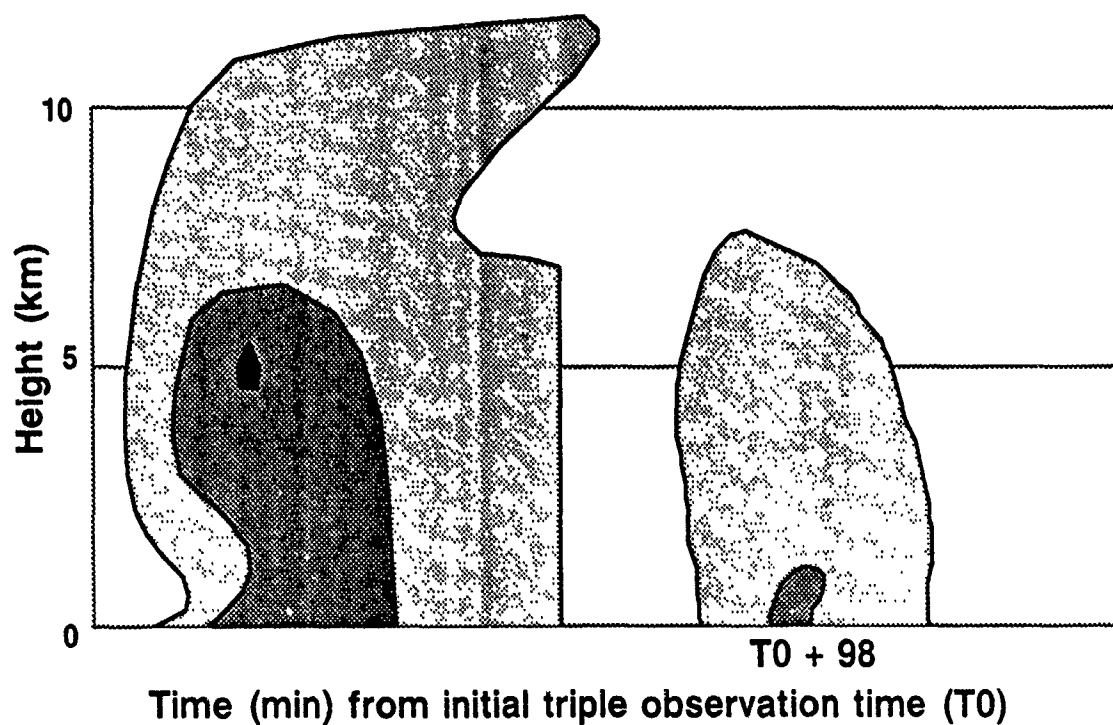
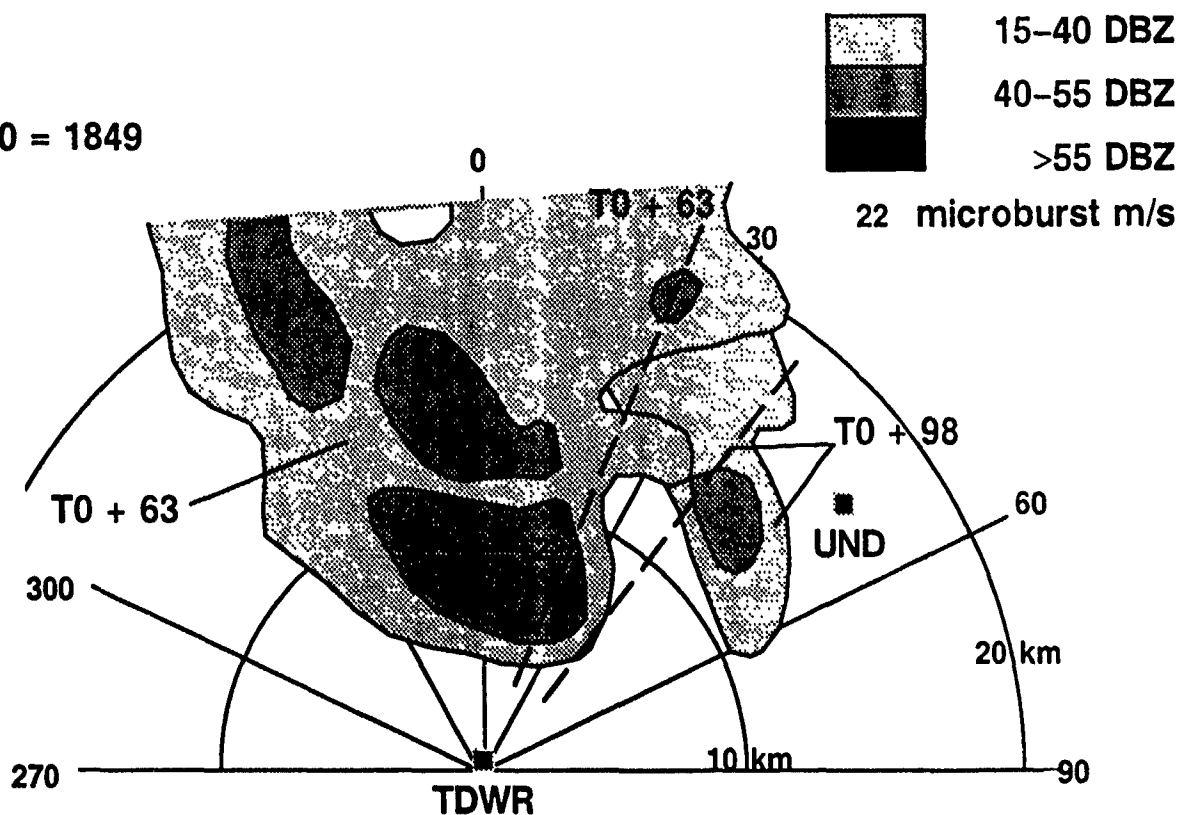
AWOS data: Yes

Interferometer data: None

Corona point data: None

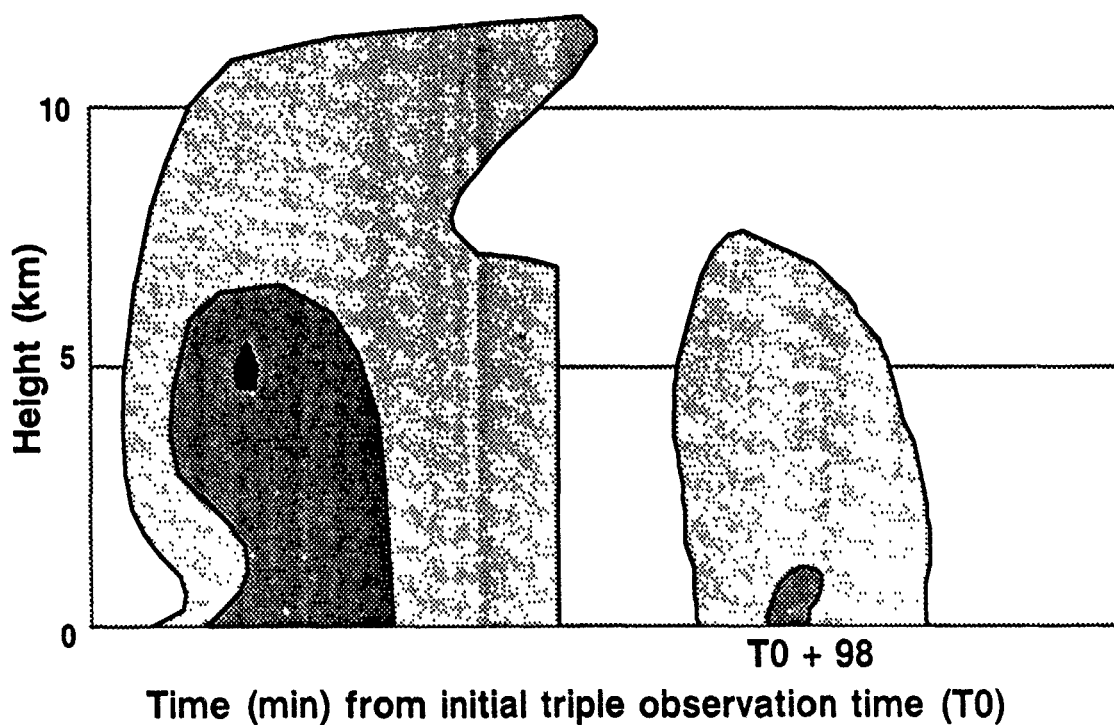
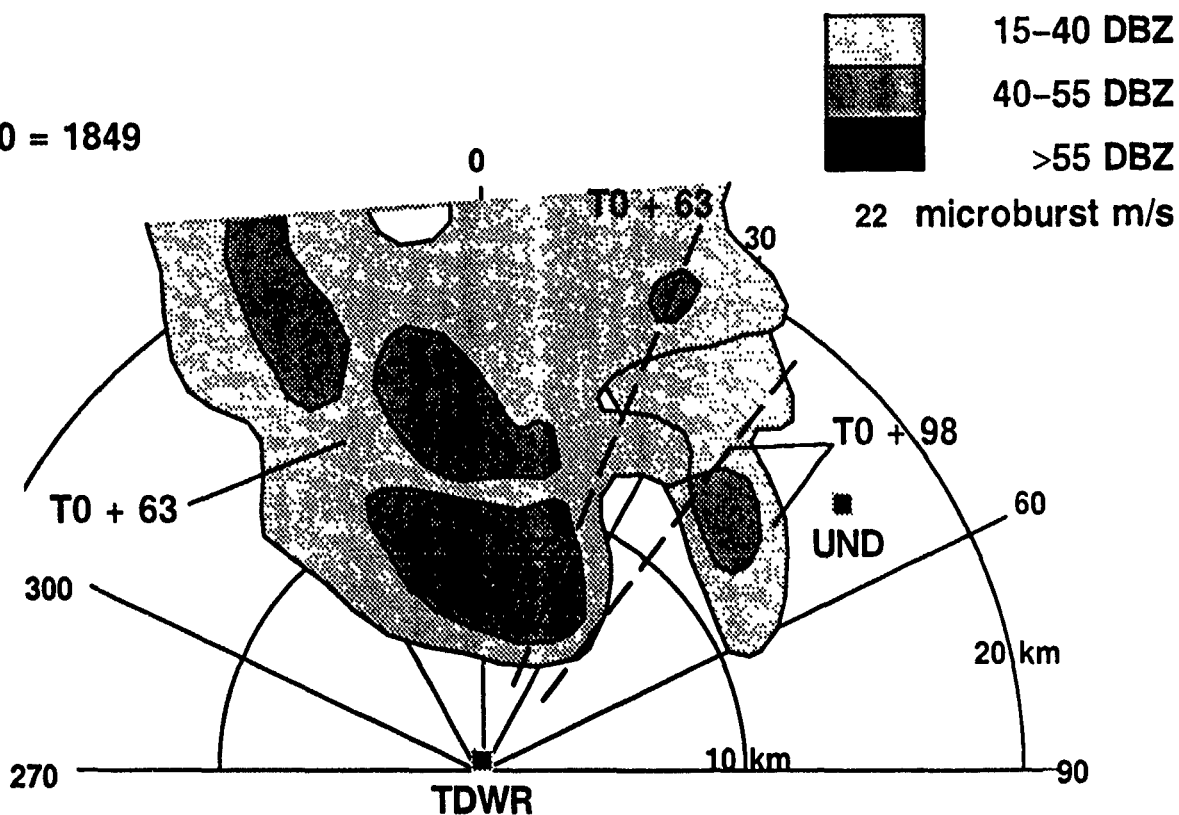
15 AUGUST 91

T0 = 1849



15 AUGUST 91

T0 = 1849



19 AUGUST 91

Description: A few small airmass thunderstorms formed on this day. The two that formed earliest in the triple period did not grow to any great extent, but they did produce weak microbursts as they exited the triple Doppler region. Later in the triple period, a pair of westward moving cells merged, and passed just to the north of the TDWR testbed. As the thunderstorm passed the radar, it began to dissipate after producing a 16 m/s outflow. The sounding taken at 1656 GMT showed light to moderate southerly winds at the surface, and moderate westerly winds above the surface layer to 7 km. Above that, the winds were light to moderate from the north. The freezing level was 4.9 km, the surface temperature was 29.8°C, the dew point was 21.2°C, and the lifted condensation level was 0.8 km.

The accompanying sketch shows the three thunderstorms that passed through the triple Doppler region on this day. The two cells that formed earliest in the triple period are shown as they appeared before moving outside the triple region, at $T_0 + 1$ min and $T_0 + 13$ min respectively. Two cells that formed later in the triple period merged and are shown at $T_0 + 64$ min, and the resultant thunderstorm is shown at $T_0 + 87$ min.

Triple Doppler Times: 1712 - 1903, MIT/UND/TDWR

Total Coverage Times: 1651 - 2151, TDWR
1702 - 1929, UND
1501 - 0151, MIT

Site Observations: MB (12 m/s) 1720 (16/024)
GF (5 m/s) 1821 (13/016), MCO
MB (14 m/s) 1839 (06/355), MCO ✓†

Dual Doppler Times: 1903 - 1919 MIT/TDWR

RHI Scans: MIT
1505 - 1705, NE/SE
1937 - 1942, NE/E/SE
UND
1904 - 1914, E/SE
1919 - 1948, intermittent between volume scans
TDWR
1711 - 1751, 1830 - 1910, 1925 - 1938, 2052 - 2151, intermittent between volume scans

ASR-WSP data: 1714 - 1718
1831 - 1855

Sounding Times: 1130, 1351, 1656, 1955

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: None

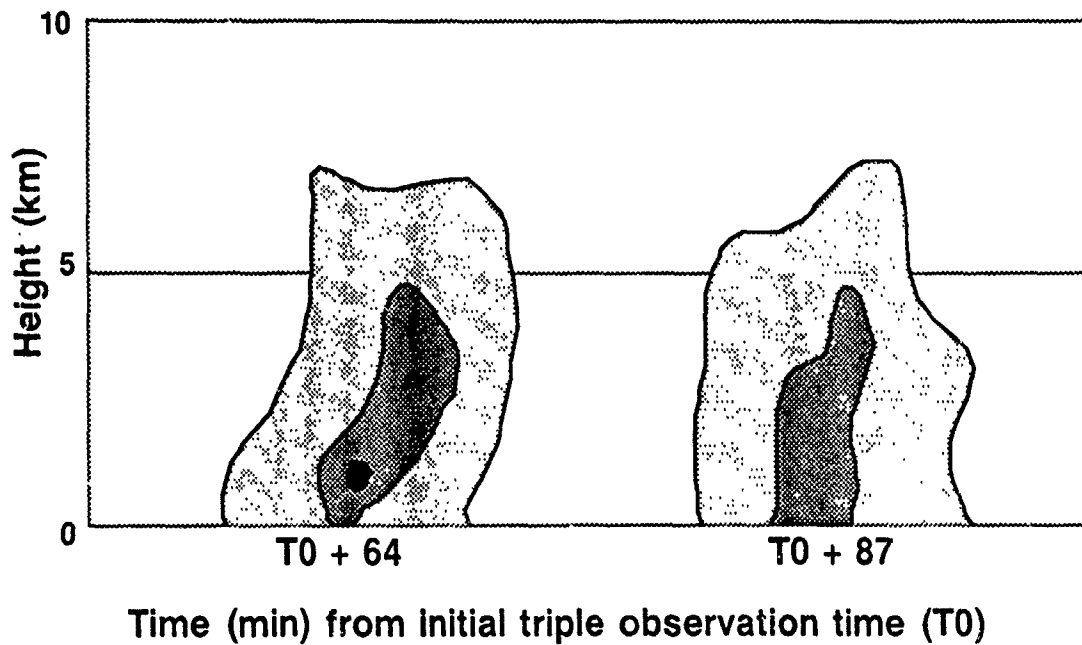
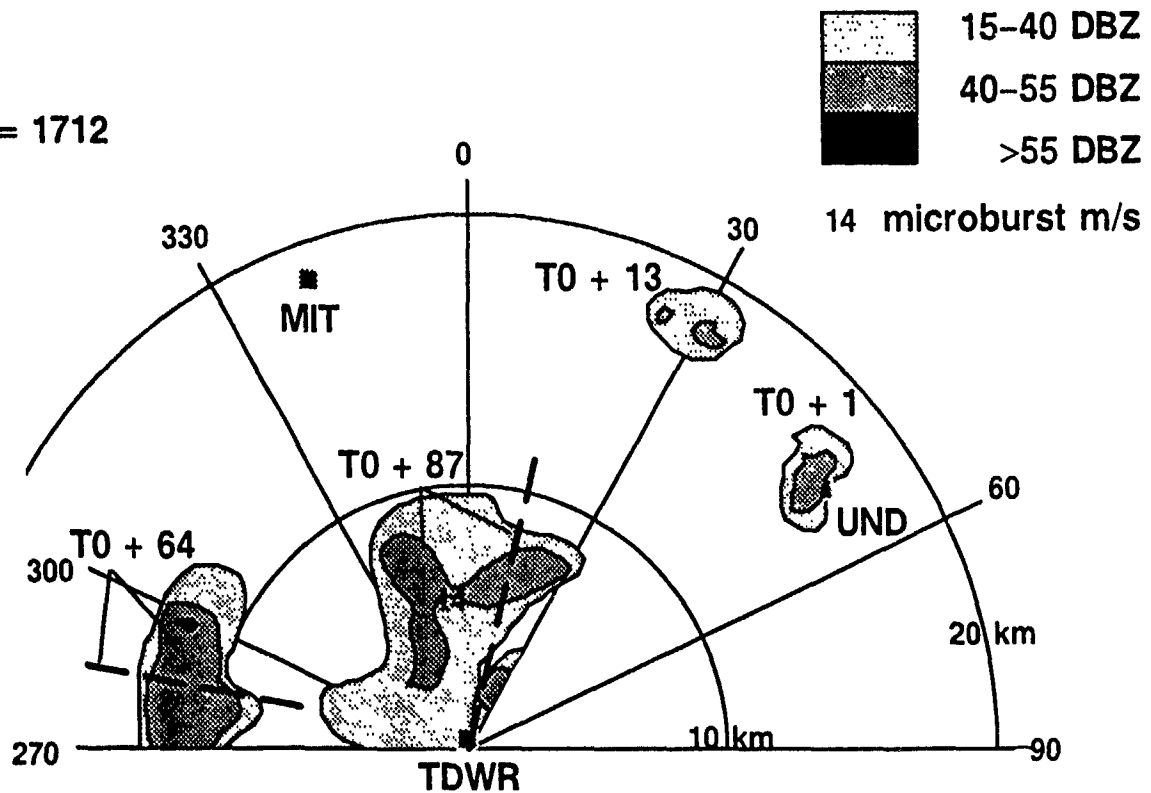
AWOS data: Yes

Interferometer data: None

Corona point data: 1712 - 1903
Stations C14, C3, C6

19 AUGUST 91

T0 = 1712



24 AUGUST 91

Description: Numerous showers and thunderstorms moved rapidly from the S through the triple Doppler region. A few thunderstorms developed in the triple region, but quickly moved out of the region. One large multicell complex moved rapidly into the region from the S, developing further as it passed through. The complex produced two weak microbursts within the triple sector. A large band of thunderstorms passed to the E of the UND radar, just outside of the triple region. The sounding taken at 1658 GMT showed moderate southerly flow from the surface to 13 km. The surface temperature was 28.1°C, the dew point was 20.6°C, the freezing level was 4.9 km, and the lifted condensation level was 0.7 km.

The accompanying sketch shows the multicell complex as it develops and moves through the triple Doppler region. At $T_0 + 130$ min the complex is just entering the triple region, and by $T_0 + 142$ min the complex has expanded and reached the northern edge of the region. (The southern portion of the storm is not shown so as not to obscure the data at $T_0 + 130$ min.) The RHIs show the vertical extent of the complex at these two times.

Triple Doppler Times: 1644 – 1929, MIT/UND/TDWR

Total Coverage Times: 1623 – 2042, TDWR
1641 – 1937, UND
1624 – 2051, MIT

Site Observations: GF (6 m/s) 1857 (10/348), MCO
MB (14 m/s) 1859 (06/315), MCO ✓† (shown in the sketch at 1906)
MB (10 m/s) 1909 (07/003), MCO

Dual Doppler Times: 1929 – 1944 MIT/TDWR

RHI Scans: MIT
1628 – 1642, SW
1956, SE
2011 – 2051, SE/NE
UND
1929 – 1930, 1933 – 1936, SW
TDWR
1723 – 1747, 1814 – 1938, intermittent between volume scans
1944, NE

ASR-WSP data: None

Sounding Times: 1147, 1401, 1658

Aircraft data: Westinghouse BAC1-11 on site for flight tests of forward looking radar with MB detection capability.

ACARS data: Yes

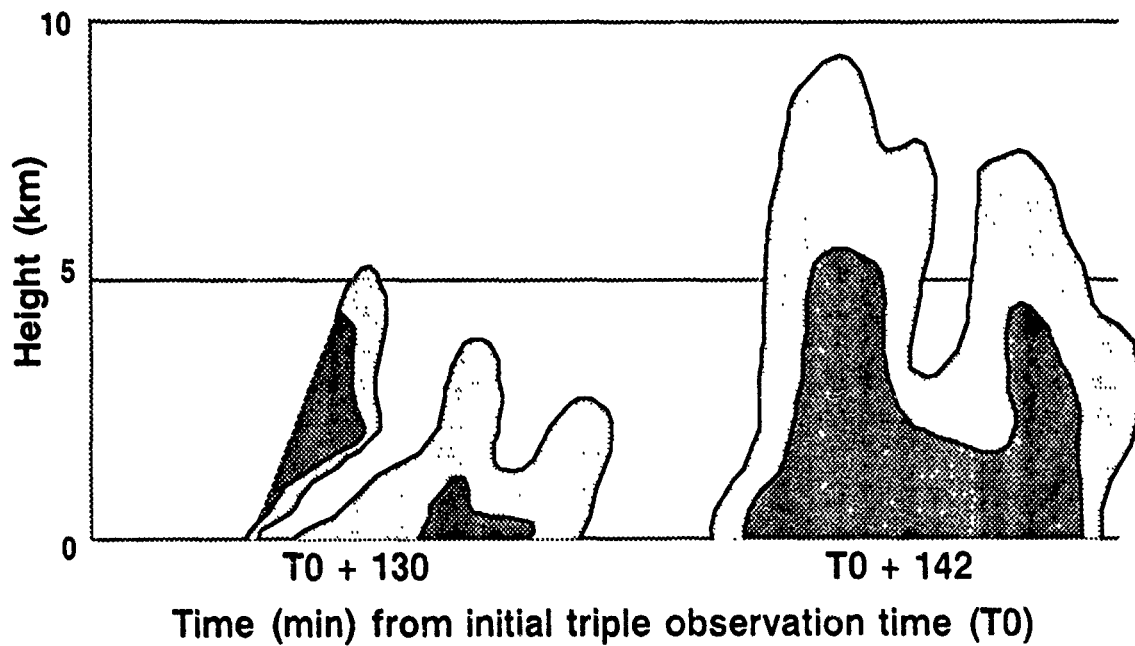
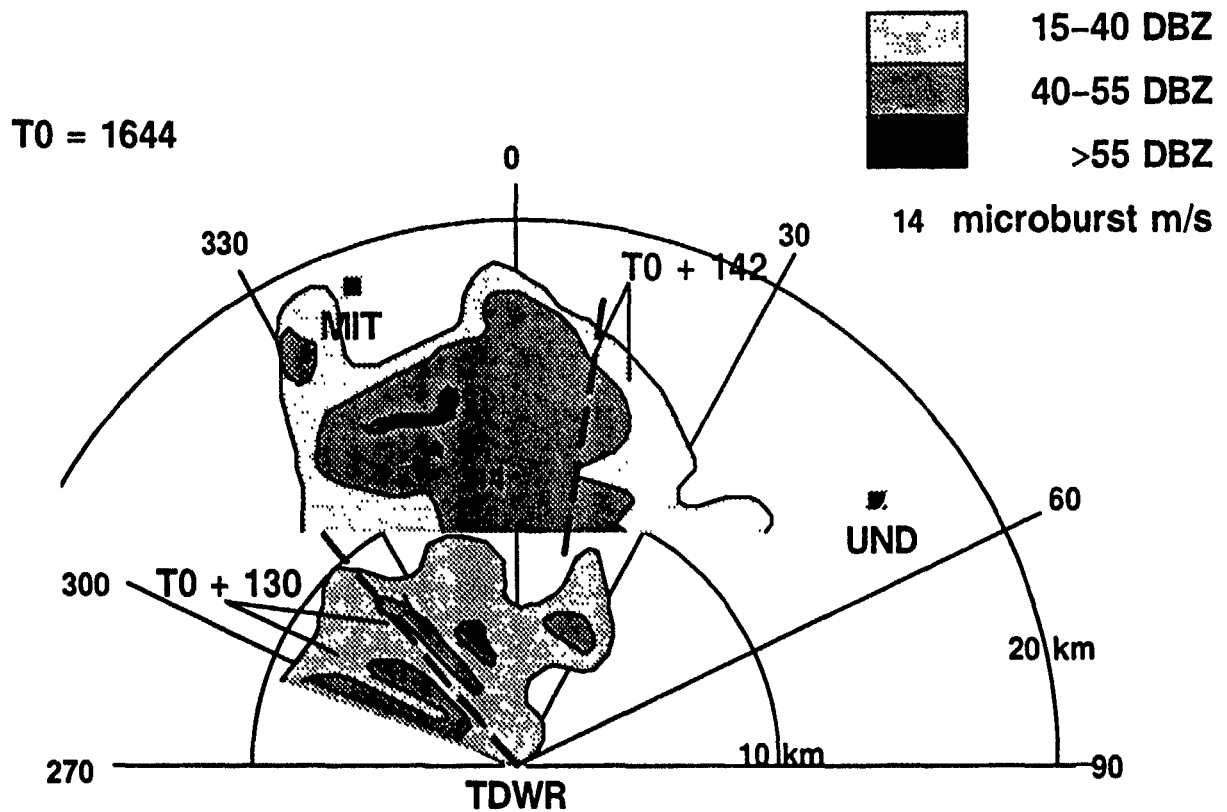
Mesonet and LLWAS data: None

AWOS data: Yes

Interferometer data: None

Corona point data: 1644 - 1929
Stations C14, C25, C24, C33, C28, C3, C22, C6, C1

24 AUGUST 91



25 AUGUST 91

Description: A gust front moved through the triple Doppler region from W to E, triggering rapid development behind it. A long line of thunderstorms formed in the triple region with the same orientation as the front, and developed even further as it moved to the E. The line produced several outflows within the triple region, but only one was strong enough to be classified as a microburst. The sounding taken at 1944 GMT showed light easterly flow at the surface, which shifted to moderate southwesterly flow above the surface layer to the freezing layer (5.8 km). The winds were strongest from the SE, just above the freezing layer, and became lighter above. The surface temperature was 25.8°C, the dew point was 22.4°C, and the lifted condensation level was 0.3 km.

The accompanying sketch shows the initial cells that formed behind the gust front at $T_0 + 7$ min. These cells expanded and grew into a long, strong line of thunderstorms at $T_0 + 67$ min.

Triple Doppler Times: 2121 - 2233, MIT/UND/TDWR

Total Coverage Times: 1614 - 2312, TDWR
1746 - 2317, UND
1514 - 2314, MIT

Site Observations: GF (6 m/s) 1839 (11/015), MCO
GF (7 m/s) 2115 (05/030), MCO
MB (11 m/s) 2215 (13/049) ↗↑ (shown in the sketch at 2228)
MB (10 m/s) 2242 (11/346), MCO

Dual Doppler Times: 2102 - 2121 UND/TDWR
2233 - 2314 MIT/TDWR

RHI Scans: MIT
1516 - 1650, NE/E/N
1655 - 1656, 1702, 1705 - 1706, SE
1711 - 1811, NE/SE
1811 - 1937, NW
1938 - 2022, SW
2030 - 2117, SW/S
UND
2233 - 2239, E/SE
2240 - 2258, E/SE
TDWR
2008 - 2009, 2014 - 2015, 2020 - 2021, 2130 - 2300
intermittent between volume scans

ASR-WSP data: None

Sounding Times: 1203, 1350, 1646, 1944

Aircraft data: Westinghouse BAC1-11 on site for flight tests of forward looking radar with MB detection capability.

ACARS data: Yes

Mesonet and LLWAS data: 2121 - 2233

Station	1	93%	16	100%
	2	0%	17	99%
	3	88%	18	99%
	4	0%	19	100%
	5	0%	20	62%
	6	93%	21	100%
	7	92%	22	100%
	8	93%	23	100%
	9	0%	24	0%
	10	86%	25	100%
	11	0%	26	100%
	12	92%	27	100%
	13	0%	28	100%
	14	0%	29	100%
	15	0%	30	100%

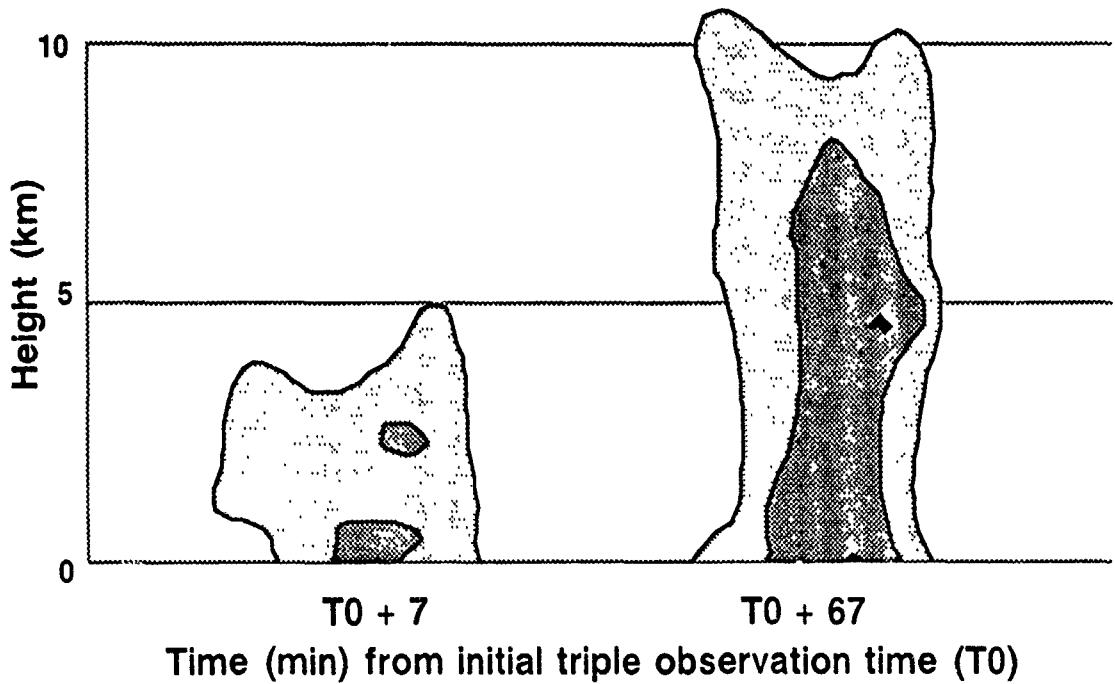
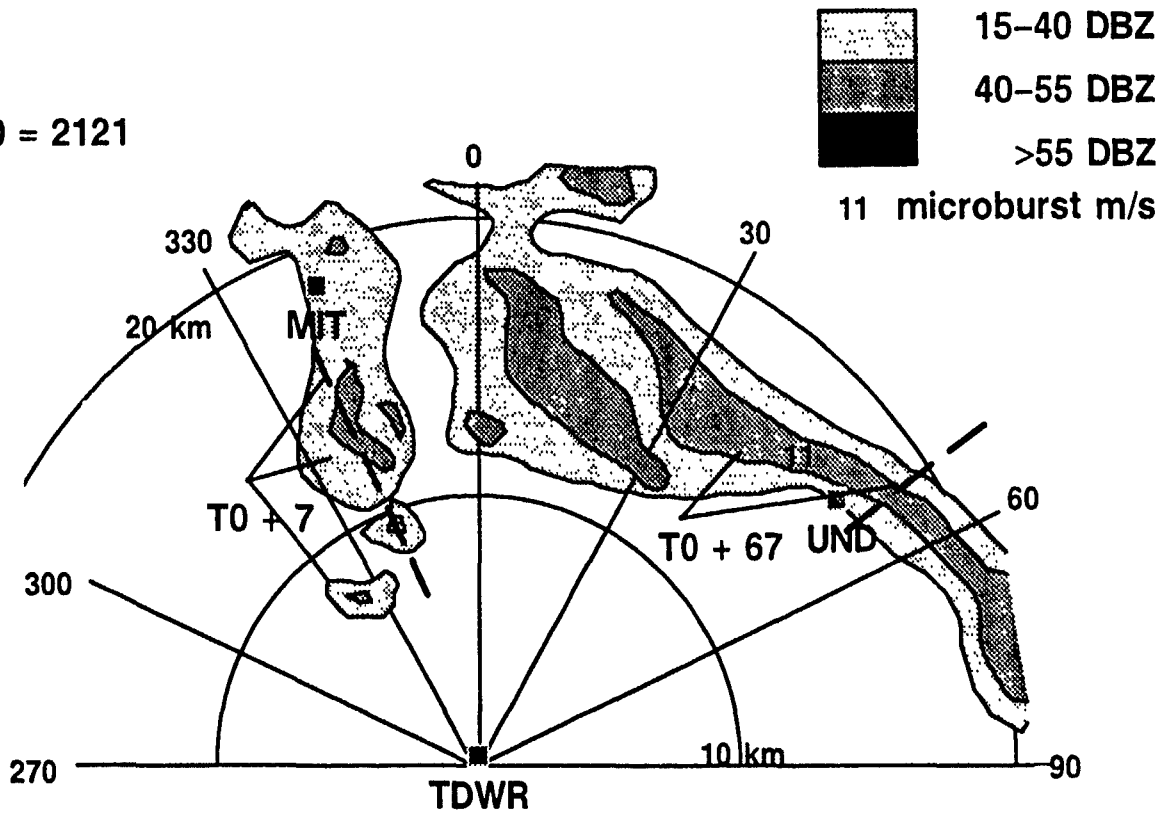
AWOS data: Yes

Interferometer data: None

Corona point data: 2121 - 2233
Stations C7, C3, C6, C1

25 AUGUST 91

T0 = 2121



30 AUGUST 91

Description: Several air mass thunderstorms formed on this day, growing and dissipating quickly. Many small cells developed within the triple Doppler region, and moved westward as they dissipated. Four produced microbursts, with strengths ranging from 12 m/s to 16 m/s. The sounding taken at 1754 GMT showed light to moderate easterly winds from the surface to 8 km, where the winds increased and shifted from easterly to northerly. The freezing level was 4.8 km, the surface temperature was 29.3°C, the dew point was 19.4°C, and the lifted condensation level was 0.9 km.

The accompanying sketch shows the cells that formed at various times within the triple Doppler region. RHIs were taken through two of the cells, one at $T_0 + 12$ min, and one at $T_0 + 22$ min, which produced a 12 m/s outflow.

Triple Doppler Times: 1719 - 1820, MIT/UND/TDWR

Total Coverage Times: 1639 - 2221, TDWR
1708 - 2139, UND
1717 - 2221, MIT

Site Observations: MB (12 m/s) 1741 (07/020), MCO ✓†
GF (7 m/s) 1803 (09/040), MCO
MB (14 m/s) 1838 (12/050)
MB (10 m/s) 1844 (08/345), MCO
MB (10 m/s) 1857 (11/352), MCO
MB (10 m/s) 1924 (14/359), MCO
MB (10 m/s) 1936 (13/346)
GF (4 m/s) 2101 (10/012), MCO

Dual Doppler Times: 1820 - 2139 UND/TDWR

RHI Scans: MIT
1717 - 1718, 1822 - 1940, W
TDWR
1715 - 2200, intermittent between volume scans

ASR-WSP data: 1633 - 1639
1711 - 1717
1736 - 1748
1750 - 1807
1820 - 1826
1922 - 1944

Sounding Times: 1217, 1454, 1754, 2027

Aircraft data: Westinghouse BAC1-11 on site for flight tests of forward looking radar with MB detection capability.

ACARS data: Yes

Mesonet and LLWAS data: 1719 - 1820

Station	1	93%	16	99%
	2	0%	17	99%
	3	93%	18	57%
	4	0%	19	99%
	5	0%	20	99%
	6	92%	21	99%
	7	93%	22	99%
	8	90%	23	99%
	9	0%	24	0%
	10	85%	25	100%
	11	0%	26	100%
	12	0%	27	100%
	13	0%	28	100%
	14	0%	29	100%
	15	0%	30	100%

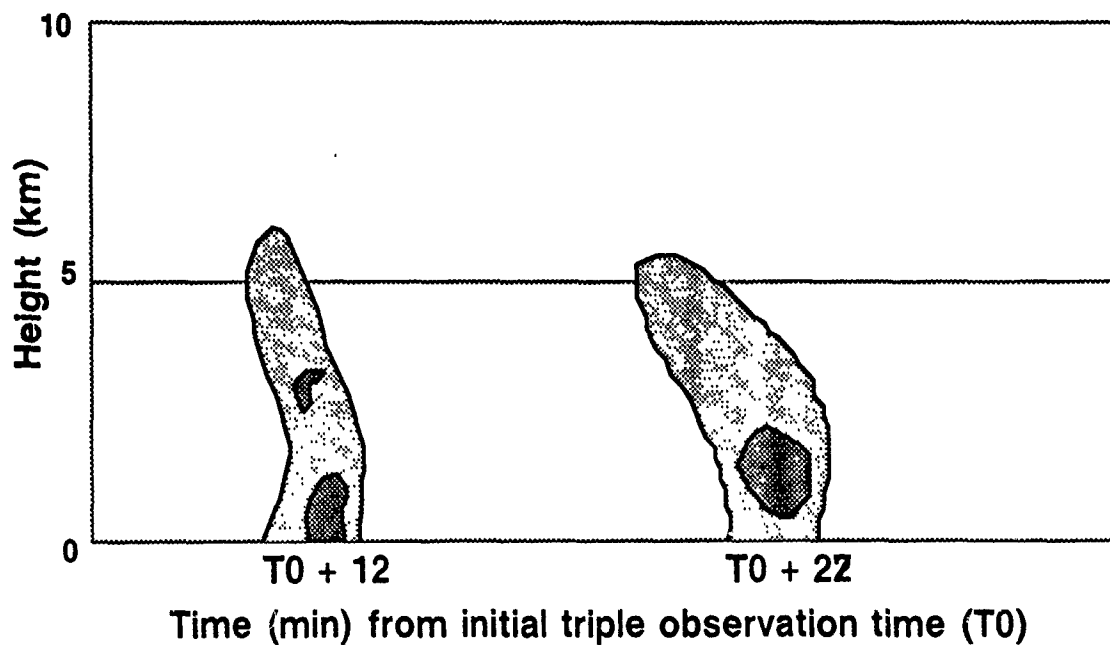
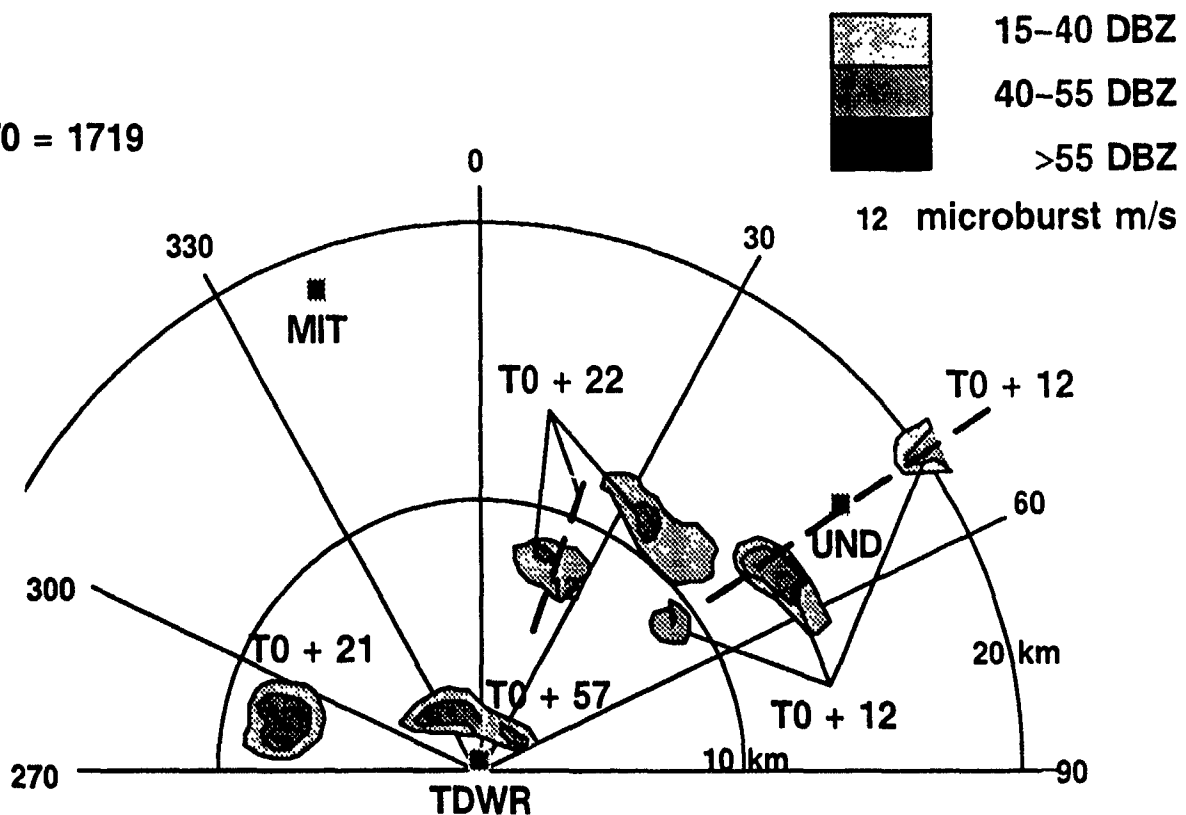
AWOS data: Yes

Interferometer data: None

Corona point data: 1719 - 1820
None

30 AUGUST 91

T0 = 1719



31 AUGUST 91

Description: A narrow line of thunderstorms moved southwestward across the triple Doppler region. As it moved, new development took place along the northwestern end of the line, while the cells at the southeastern end dissipated. Two microbursts were observed at the surface embedded in a long divergence line. By the time the line passed out of the triple sector, it had mostly dissipated. The sounding taken at 2053 GMT showed light easterly winds at the surface, light and variable winds up to the freezing level (5.6 km), and moderate to strong northwesterly winds above. The surface temperature was 26.7°C, the dew point was 19.8°C, and the lifted condensation level was 0.6 km.

The accompanying sketch shows the line as it moves toward the triple Doppler region at $T_0 + 7$ min and the new development at the western end of the line at $T_0 + 41$ min, the time of the maximum outflow strength of the 33 m/s microburst.

Triple Doppler Times: 2017 - 2134, MIT/UND/TDWR

Total Coverage Times: 1635 - 2203, TDWR
1628 - 2138, UND
1729 - 2205, MIT

Site Observations: GF (6 m/s) 1806 (07/356), MCO
MB (24 m/s) 2032 (11/019), MCO ✓
MB (12 m/s) 2032 (14/036)
MB (25 m/s) 2049 (09/359), MCO ✓
MB (14 m/s) 2055 (08/341) ✓
MB (33 m/s) 2058 (10/327) ✓†

Dual Doppler Times: 1659 - 2017 UND/TDWR

RHI Scans: MIT
1348 - 2016, NE/E/SE
2141 - 2149, NW
UND
1726 - 1729, SE
2008, N
TDWR
1934 - 2132, intermittent between volume scans

ASR-WSP data: 1930 - 2002
2026 - 2046
2047 - 2121

Sounding Times: 1215, 1450, 1745, 2053

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 2017 - 2134

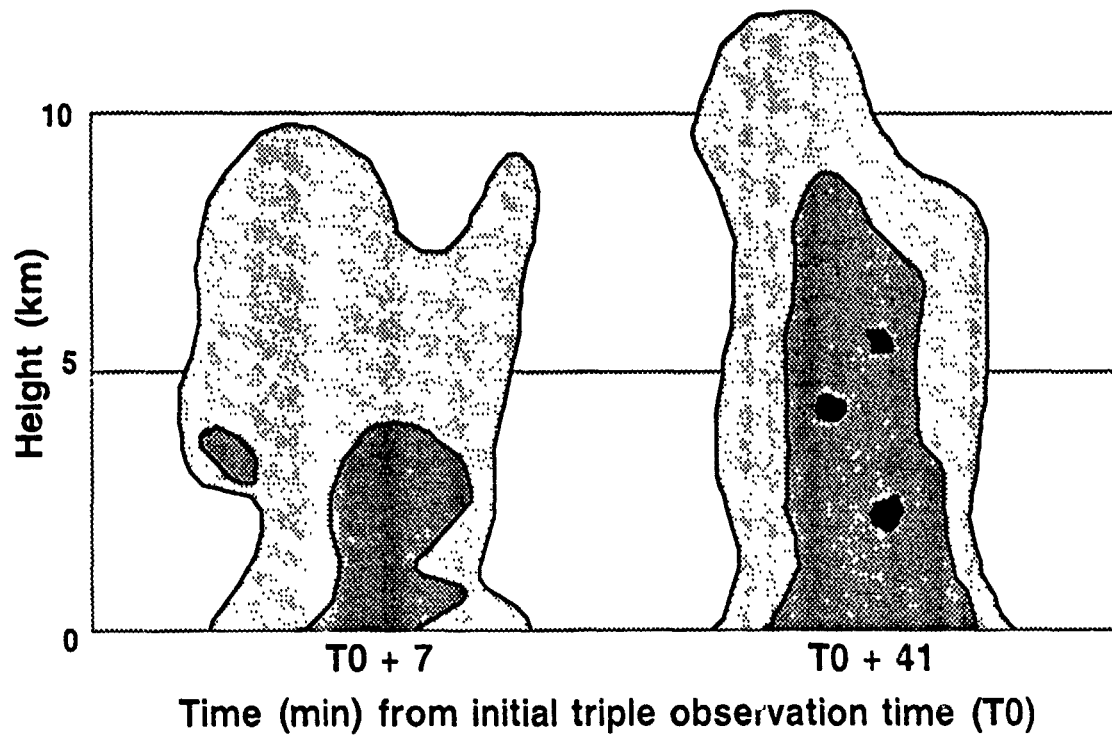
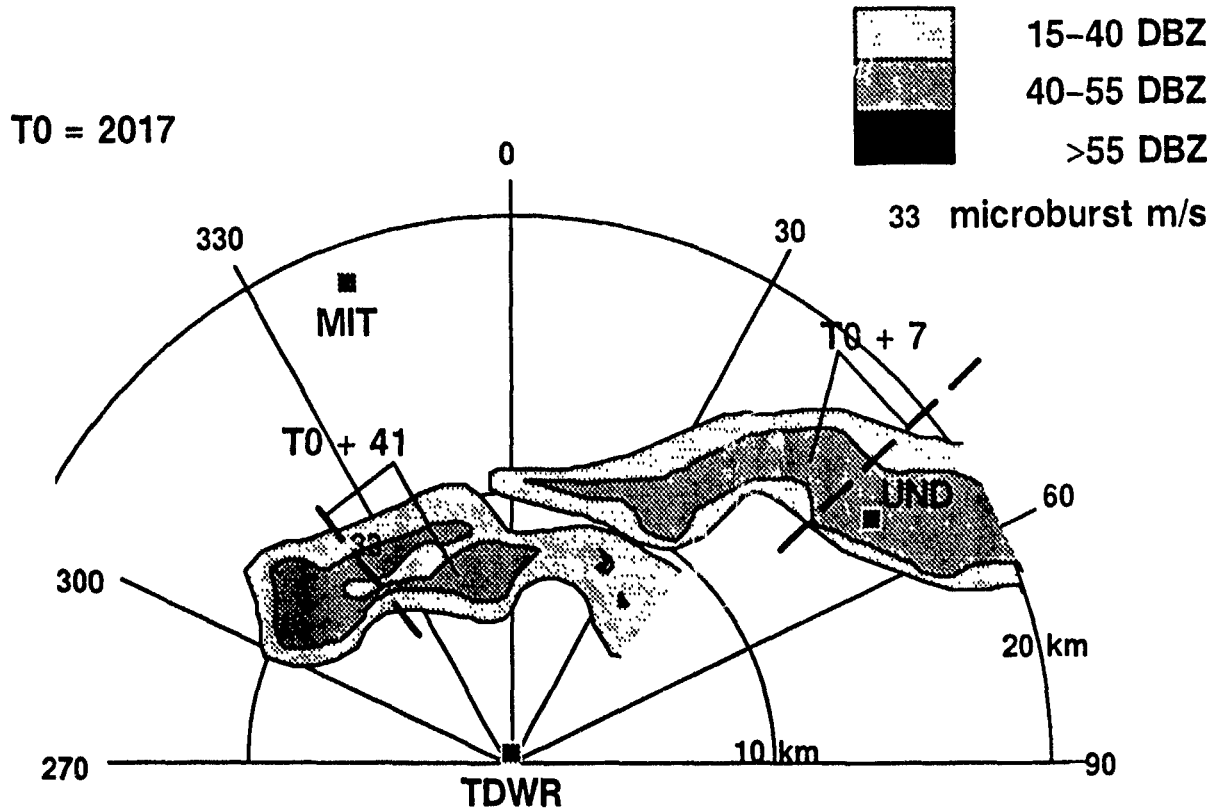
Station	1	0%	16	31%
	2	0%	17	39%
	3	0%	18	93%
	4	0%	19	94%
	5	0%	20	70%
	6	0%	21	93%
	7	0%	22	94%
	8	0%	23	94%
	9	0%	24	0%
	10	0%	25	100%
	11	0%	26	100%
	12	0%	27	100%
	13	0%	28	100%
	14	0%	29	100%
	15	0%	30	100%

AWOS data: Yes

Interferometer data: None

Corona point data: 2017 - 2134
Stations C14, C25, C33

31 AUGUST 91



7 SEPTEMBER 91

Description: Many cells drifted into the triple Doppler region from the NE on this day. Most developed and dissipated quickly, without producing a microburst-strength outflow. Only two developed within the triple region, both forming in the same area and following the same path. Both produced microbursts, as did a cell that drifted into the northern part of the triple region. The sounding taken at 2050 GMT showed light northeasterly winds below the freezing level (4.9 km), and light north-northeasterly winds above. The surface temperature was 28.8°C, the dew point was 21.5°C and the lifted condensation level was 0.6 km.

The accompanying sketch shows the microburst-producing cells that passed through the triple Doppler region. The cell that drifted into the triple region and produced a microburst is shown at $T_0 + 62$ min. The first cell to develop in the triple region is not shown, but its location at the time of maximum outflow strength, $T_0 + 38$ min, is similar to that of the cell shown at $T_0 + 77$ min. The second cell that developed in the triple region is shown at $T_0 + 77$, the time of maximum outflow.

Triple Doppler Times: 1930 - 1951, 2016 - 2112, MIT/UND/TDWR
*data gap (1951 - 2016) is due to faulty UND tape, SEP07B.

Total Coverage Times: 1929 - 2155 TDWR
1925 - 1951, 2016 - 2112 UND
1545 - 2306 MIT

Site Observations: MB (16 m/s) 1931 (10/230), MCO
MB (11 m/s) 1940 (03/025), MCO
MB (16 m/s) 2005 (09/353), MCO
MB (12 m/s) 2017 (08/321), MCO
MB (16 m/s) 2047 (09/337), MCO ✓†
MB (14 m/s) 2047 (10/006), MCO ✓

Dual Doppler Times: 1951 - 2016, MIT/TDWR

RHI Scans: MIT
1723 - 1807, NE/SW
1918, SE
2115, 2119 - 2130, S/SE
2138 - 2142, NW
2156 - 2202, 2251 - 2253, SE
2301, S

ASR-WSP data: None

ASR-WSP data: None

Sounding Times: 1227, 1453, 1752, 2050

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 1930 - 1951

Station	1	91%	16	99%
	2	90%	17	80%
	3	94%	18	99%
	4	0%	19	99%
	5	94%	20	97%
	6	0%	21	99%
	7	94%	22	99%
	8	94%	23	99%
	9	0%	24	0%
	10	93%	25	100%
	11	0%	26	100%
	12	93%	27	100%
	13	95%	28	100%
	14	0%	29	100%
	15	0%	30	100%

2016 - 2112

Station	1	93%	16	92%
	2	93%	17	47%
	3	93%	18	92%
	4	0%	19	92%
	5	92%	20	66%
	6	0%	21	91%
	7	94%	22	92%
	8	94%	23	92%
	9	0%	24	0%
	10	94%	25	100%
	11	0%	26	100%
	12	93%	27	100%
	13	93%	28	100%

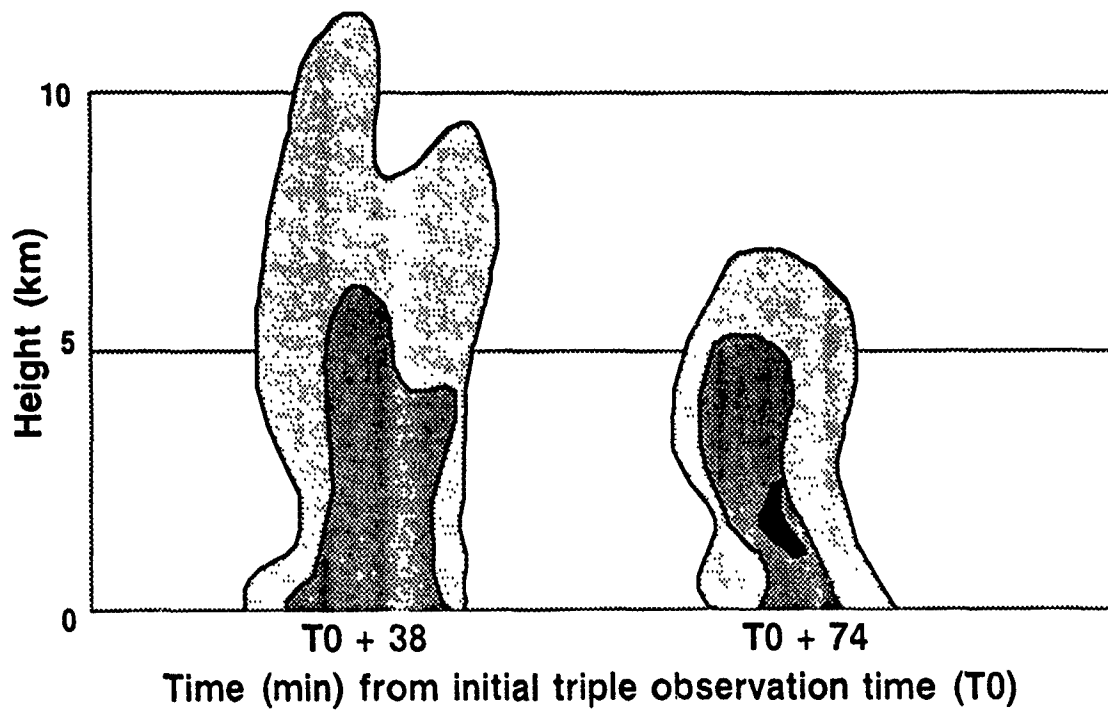
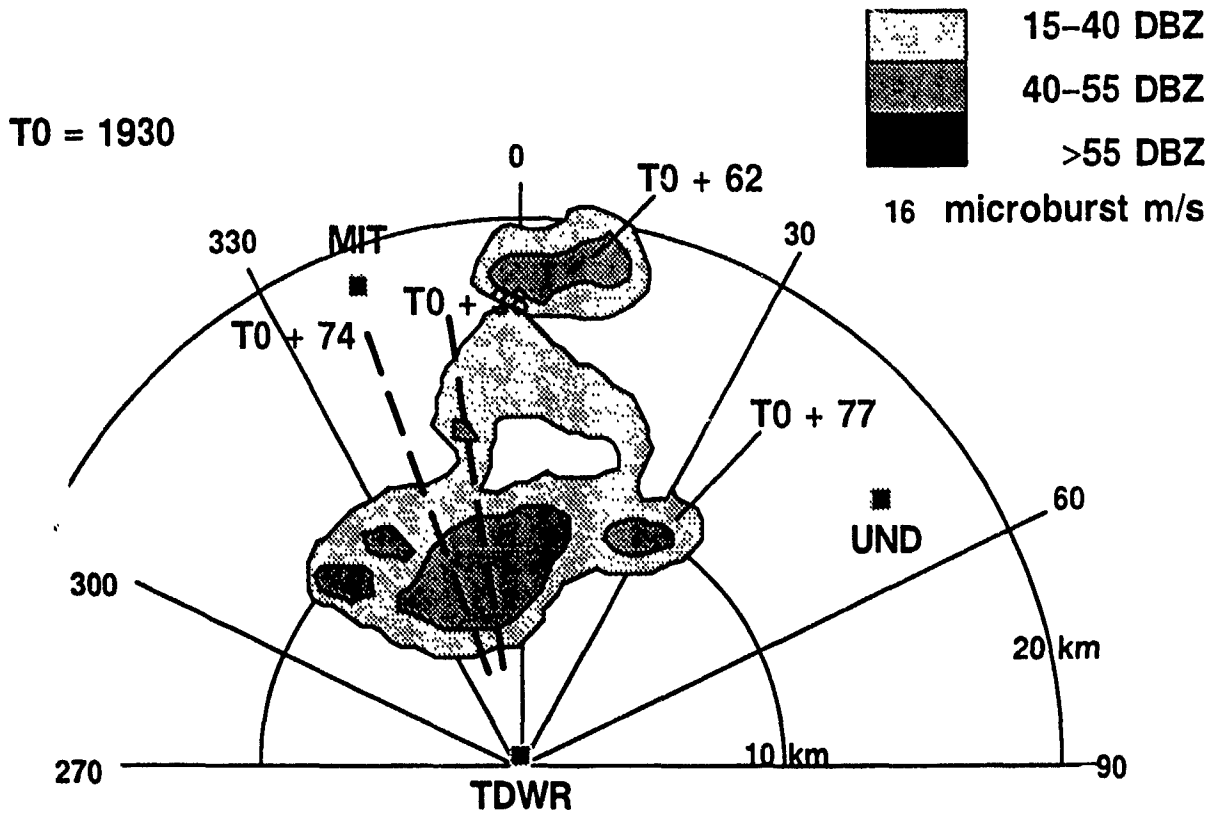
14	0%	29	100%
15	0%	30	100%

AWOS data: Yes

Interferometer data: None

Corona point data: None

7 SEPTEMBER 91



10 SEPTEMBER 91

Description: Some small cells formed quickly in the triple Doppler section, but also dissipated quickly while moving to the SW. One small cell formed early in the triple period, produced a weak microburst, and dissipated within 10 minutes. A second dissipating storm early in the triple period also produced a weak microburst near the TDWR testbed. The only other cell to produce a microburst in the triple region drifted in from the NE. It continued to develop after entering the triple region, and produced the microburst shortly before passing over the TDWR testbed. The sounding taken at 1747 GMT showed light to moderate northeasterly winds at the surface, light and variable winds to the freezing level (5.0 km), and light to moderate winds above. The surface temperature was 26.8°C, the dew point was 20.7°C, and the lifted condensation level was 0.5 km. The sounding taken at 1850 GMT showed similar conditions.

The accompanying sketch shows a cell that developed early in the triple period to the NW of the TDWR testbed at the time of its maximum outflow strength, $T_0 + 15$ min. Another early cell is not shown, but an RHI of the cell is shown, at $T_0 + 3$ min. The other cell to produce a microburst in the triple region is shown at $T_0 + 69$ min, the time of maximum surface outflow strength.

Triple Doppler Times: 1710 - 1858, 1900 - 1912, MIT/UND/TDWR

Total Coverage Times: 1705 - 2016, TDWR
1710 - 1952, UND
1512 - 2152, MIT

Site Observations: MB (12 m/s) 1706 (03/020), MCO
MB (10 m/s) 1806 (03/032), MCO
MB (16 m/s) 1817 (02/351), MCO ✓†
GF (7 m/s) 1824 (11/338), MCO
MB (12 m/s) 1836 (13/344)

Dual Doppler Times: 1912 - 1952 UND/TDWR

RHI Scans: MIT
1520 - 1708, E/SE
1858 - 1900, S/SW
1914 - 2142, 2152, SW
UND
1839, SW
1842, W

ASR-WSP data: None

Sounding Times: 1220, 1502, 1747, 1850

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: 1710 - 1858

Station	1	92%	16	100%
	2	92%	17	91%
	3	92%	18	100%
	4	94%	19	100%
	5	0%	20	64%
	6	0%	21	99%
	7	92%	22	100%
	8	92%	23	100%
	9	0%	24	0%
	10	93%	25	100%
	11	0%	26	100%
	12	94%	27	100%
	13	0%	28	100%
	14	0%	29	100%
	15	0%	30	100%

1900 - 1912

Station	1	89%	16	100%
	2	95%	17	63%
	3	90%	18	96%
	4	89%	19	100%
	5	0%	20	14%
	6	0%	21	100%
	7	93%	22	100%
	8	90%	23	100%
	9	0%	24	0%
	10	92%	25	100%
	11	0%	26	100%
	12	90%	27	100%
	13	0%	28	100%
	14	0%	29	100%
	15	0%	30	100%

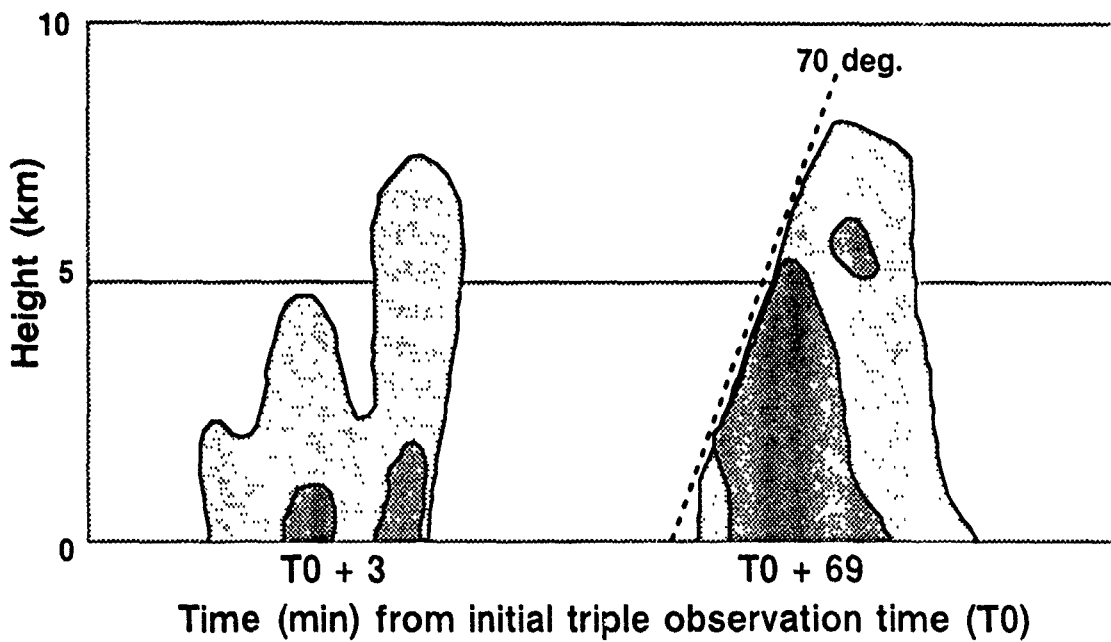
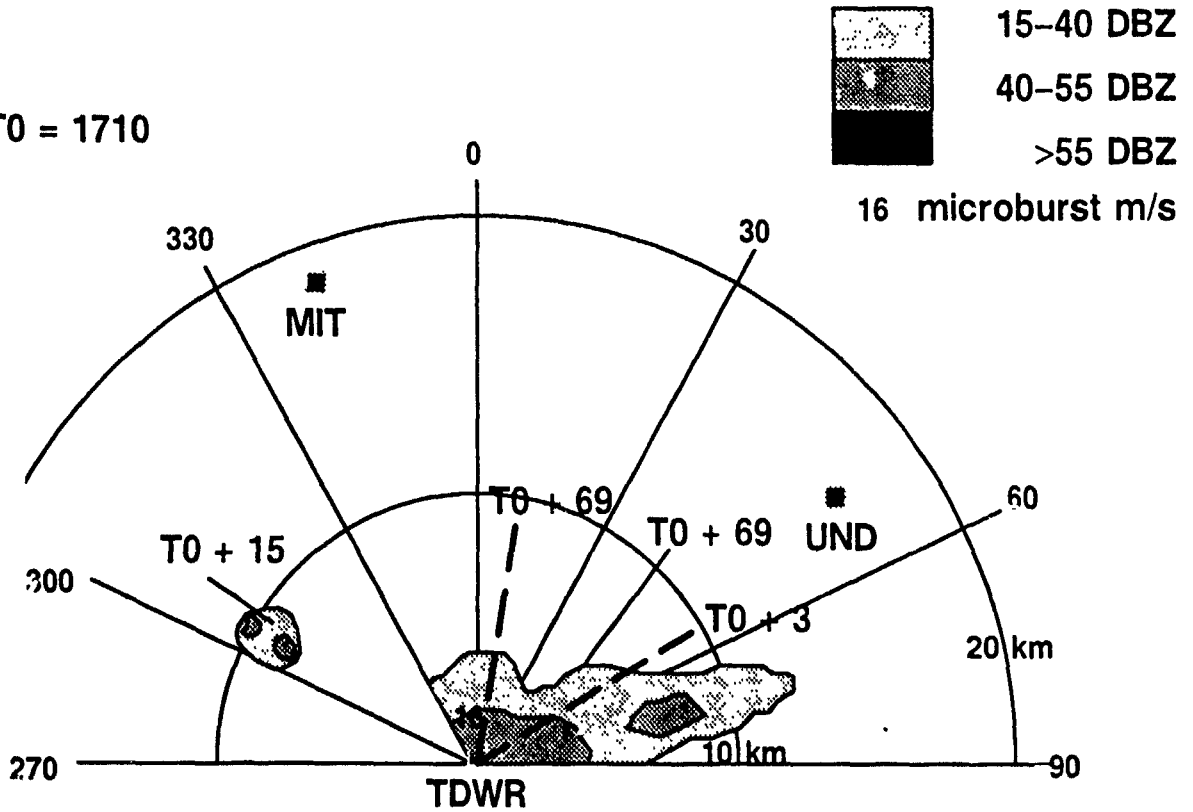
AWOS data: Yes

Interferometer data: None

Corona point data: None

10 SEPTEMBER 91

T0 = 1710



16 SEPTEMBER 91

Description: A cell rapidly developed in the triple Doppler region and proceeded to move to the SW over the TDWR testbed. A 14 m/s microburst was produced near the TDWR testbed as the cell passed by. As the cell moved outside the triple region, new development took place along the leading edge. The sounding taken at 1810 GMT showed light to moderate northeasterly surface winds and strong easterly winds throughout the rest of the layer. The surface temperature was 29.2°C, the dew point was 20.9°C, the freezing level was 5.4 km, and the lifted condensation level was 0.7 km.

The accompanying sketch shows the cell as it passed the TDWR testbed at $T_0 + 26$ min, the time of maximum surface outflow.

Triple Doppler Times: 1730 - 1845, 1858 - 1927, MIT/UND/TDWR

Total Coverage Times: 1714 - 1944, TDWR
1730 - 1927, UND
1642 - 2136, MIT

Site Observations: MB (14 m/s) 1756 (03/029), MCO ✓†

Dual Doppler Times: no 1 - min dual outside of triple times

RHI Scans: MIT
1701 - 1724, SE/ESE
2013 - 2014, S

ASR-WSP data: 1800 - 1805

Sounding Times: 1213, 1508, 1810, 2044

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: Yes, but it has not been processed

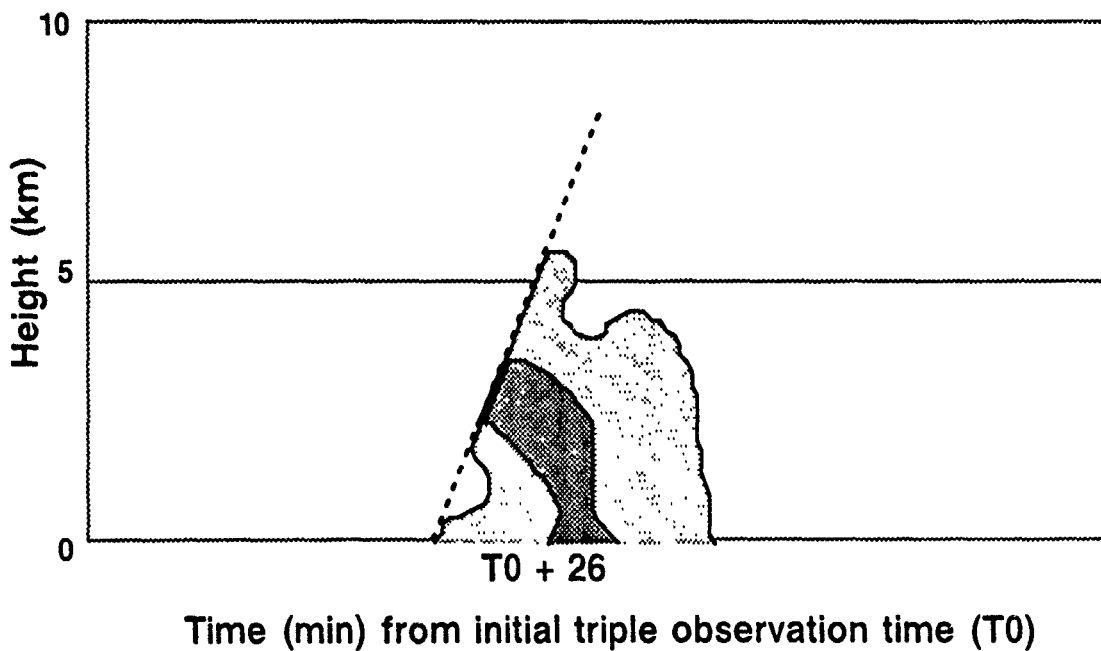
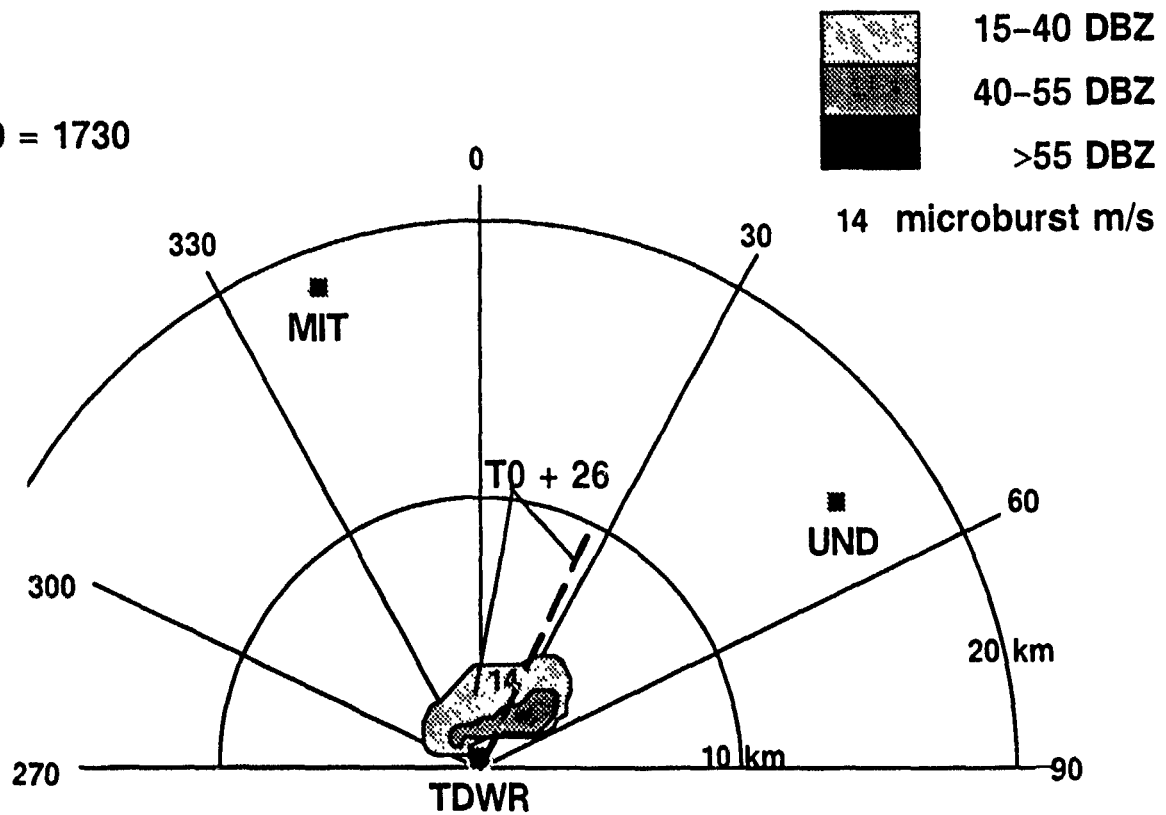
AWOS data: Yes

Interferometer data: None

Corona point data: None

16 SEPTEMBER 91

T0 = 1730



20 SEPTEMBER 91

Description: During the first triple period, a gust front passed through the triple Doppler region from N to S. A cell formed on the northern corner of the triple region behind the front, and moved southward and produced an 16 m/s microburst. A larger group of cells formed along the northeastern edge of the triple region, and stayed for the most part along that edge. One of the cells in this group produced a 14 m/s microburst along the edge of the triple region. The sounding taken at 1805 GMT taken during this triple period showed light and variable winds from the surface to 12 km. The surface temperature was 30.0°C, the dew point was 19.0°C, the freezing level was 4.7 km, and the lifted condensation level was 1.0 km.

The first accompanying sketch shows the cells that formed behind the gust front during the first triple period. The cell shown at $T_0 + 24$ min produced an 18 m/s microburst, but the outflow was outside of the triple region. An RHI at the time of maximum outflow is shown. The second cell, shown at $T_0 + 37$ min produced the 16 m/s outflow and an RHI of this cell is shown at the time of maximum outflow.

Description: During the second triple period a gust front passed through the triple region followed by a line of thunderstorms. The line moved into the triple region slowly, cells dissipating and growing along its length. The line eventually weakened as it approached the airport, and dissipated as it passed beyond. There was no sounding taken near this triple time.

There are two sketches for the second time period. The first shows the gust front that preceded the cells across the triple region. Both show the line of thunderstorms moving into the triple region, each at different stages. The RHIs show the vertical extent of this line at varying stages of its life cycle.

Triple Doppler Times: 1832 - 2000, 2301 - 0022 MIT/UND/TDWR

Total Coverage Times: 1717 - 0101, TDWR
1800 - 0022, UND
1555 - 1621, 1719 - 0106, MIT

Site Observations: GF (5 m/s) 1827 (11/353), MCO
MB (14 m/s) 1906 (14/025) ✓
MB (16 m/s) 1909 (13/028) ✓† (sketch 1)
MB (23 m/s) 1916 (14/045)
GF (5 m/s) 2056 (14/043)
GF (8 m/s) 2253 (09/355), MCO † (sketch 2, shown in sketch at 2304)
MB (12 m/s) 2336 (16/359)
MB (16 m/s) 2340 (15/354), MCO ✓† (sketch 3)

MB (10 m/s) 2343 (13/010)
MB (12 m/s) 2349 (12/357), MCO

Dual Doppler Times: 1800 – 1832, UND/TDWR
2000 – 2301 UND/TDWR

RHI Scans: MIT
1721 – 1812, NNW/NW
1820 – 1831 SW/W
2008 – 2014, S
2017 – 2138, W/SW
2150 – 2245, NNE/N/NNW/NW/W
0034 – 0106, ENE/E/SE/S
UND
2023 – 2024, 2029 – 2045, NNE/NE
2050 – 2108, E/ESE
2112 – 2127, SE
TDWR
2053 E, 2107, E

ASR-WSP data: None

Sounding Times: 1215, 1516, 1805

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: Yes, but it has not been processed

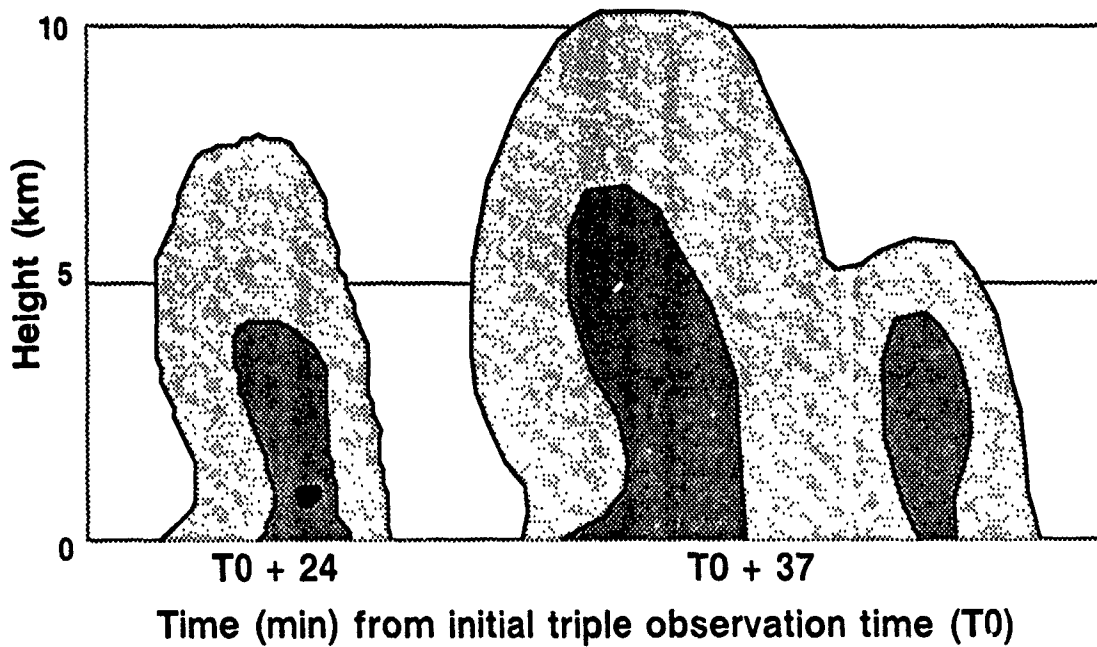
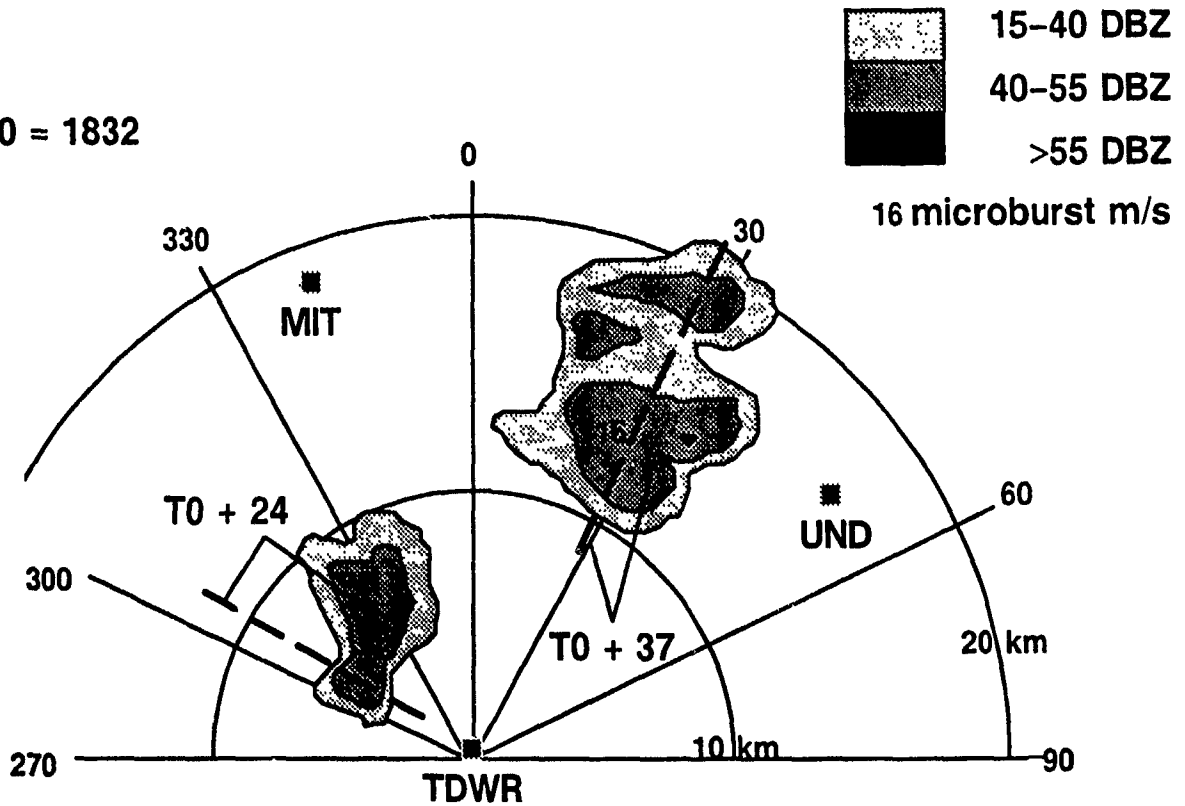
AWOS data: Yes

Interferometer data: Yes; 1814 (9/20) – 2237 (9/21)

Corona point data: 1832 – 2000
Stations C14, C25, C24, C32, C33, C28
2301 – 0022
Stations C14, C25, C24, C32, C33, C28, C39

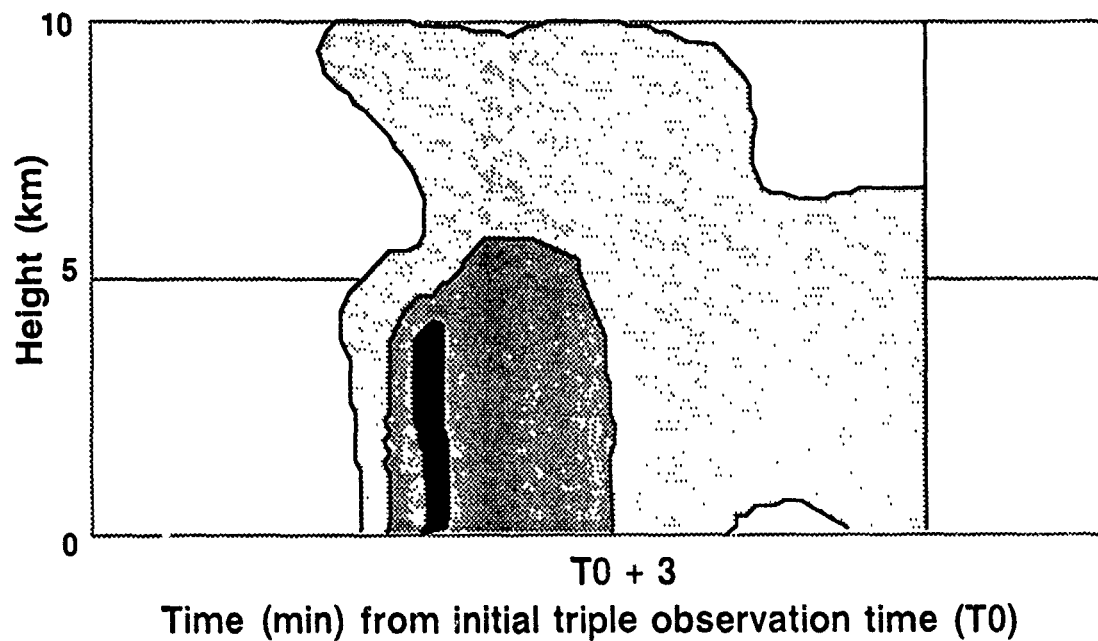
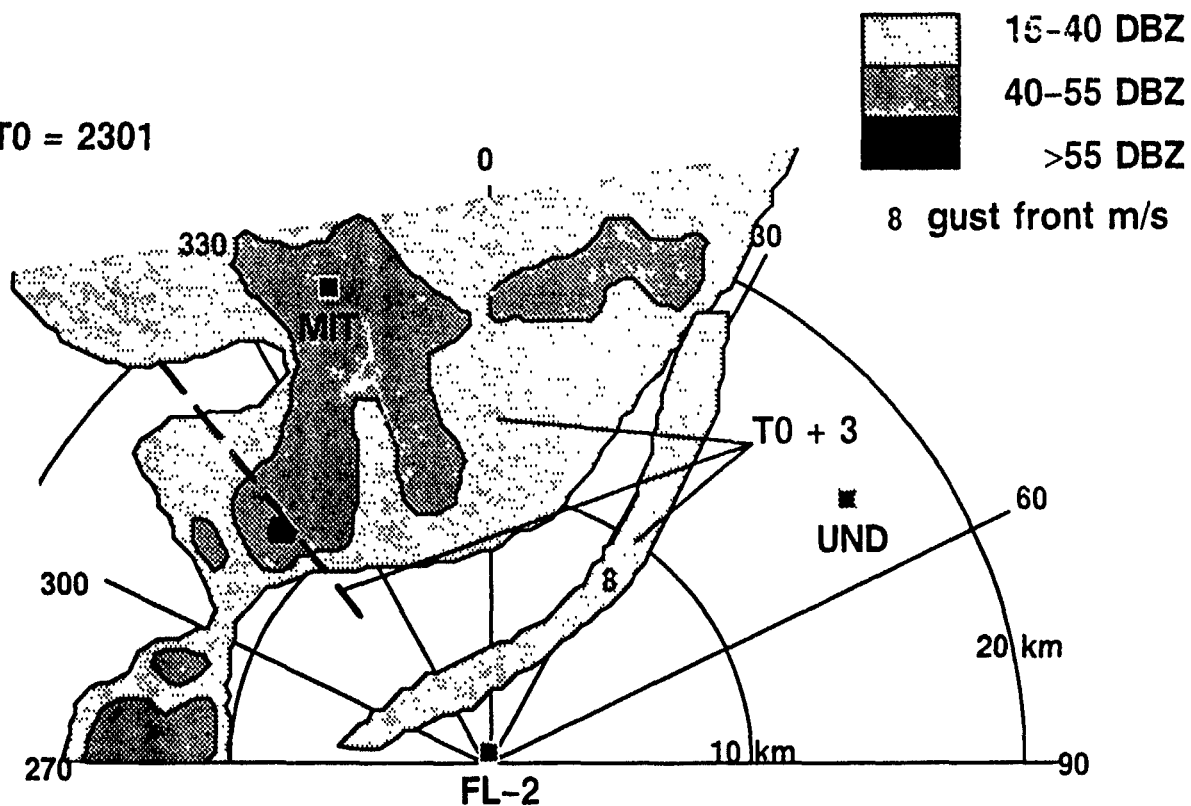
20 SEPTEMBER 91

T0 = 1832

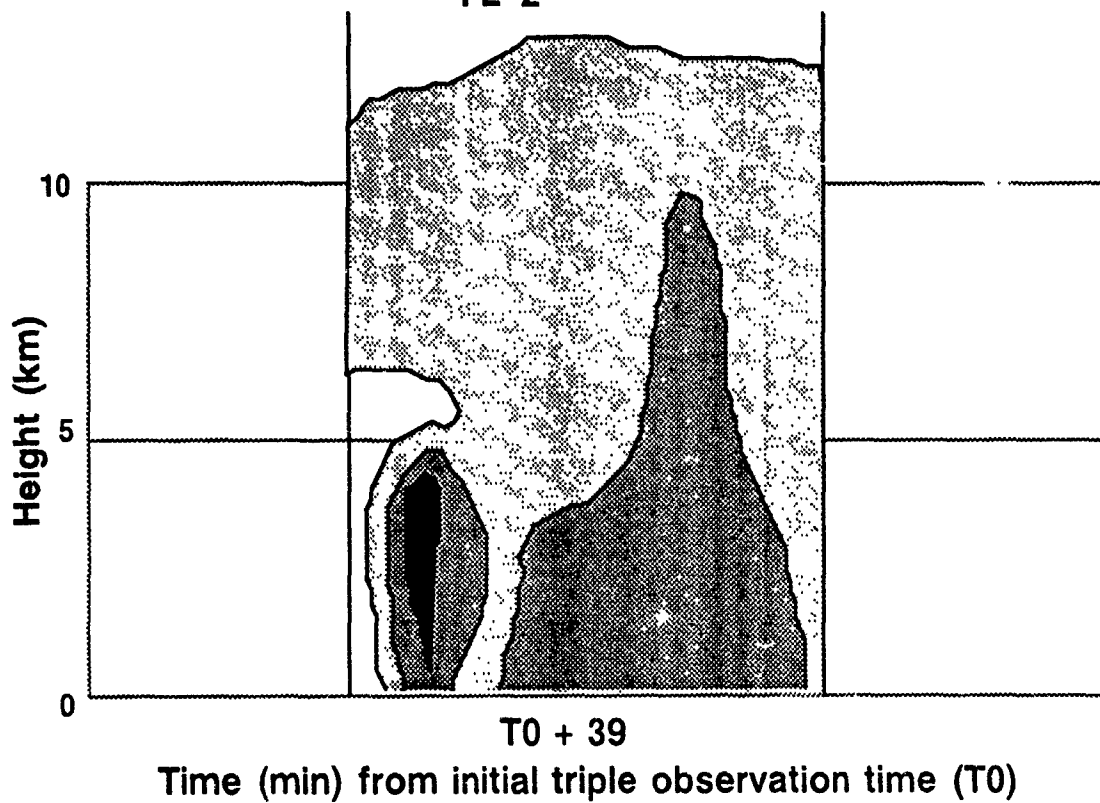
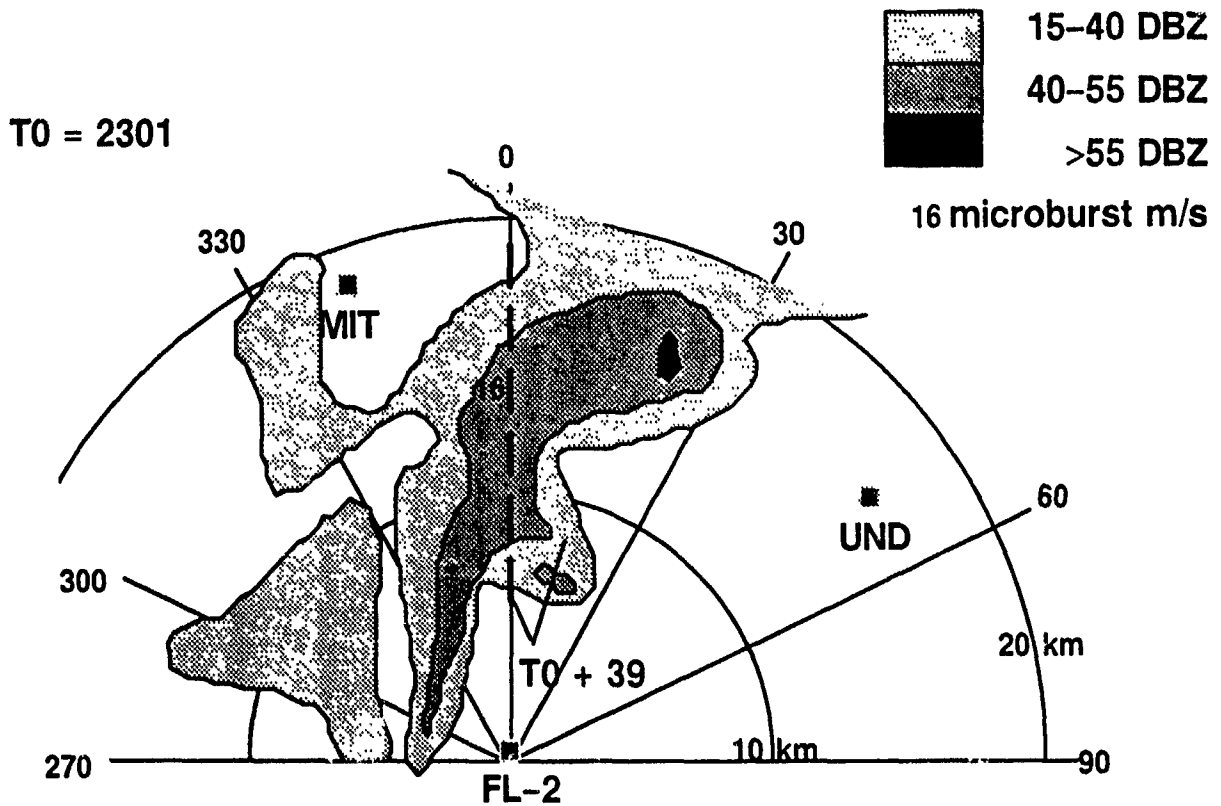


20 SEPTEMBER 91

T0 = 2301



20 SEPTEMBER 91



21 SEPTEMBER 91

Description: There was little activity within the triple Doppler region on this day. One small cell developed on the edge of the region, and moved southward past the UND radar. This cell produced a very weak microburst within the triple Doppler region before dissipating. The sounding taken at 1757 GMT showed light north-northeasterly winds below the freezing level (4.8 km), and light northwesterly winds above. The surface temperature was 29.0°C, the dew point was 20.7°C, and the lifted condensation level was 0.7 km.

The accompanying sketch shows the cell at the time of maximum outflow strength at $T_0 + 4$ min. The RHI shows the structure of the cell just prior to the maximum outflow strength.

Triple Doppler Times: 1736 - 1823, 1833 - 1844 MIT/UND/TDWR

Total Coverage Times: 1659 - 2135, TDWR
1725 - 2012, UND
1736 - 1844, MIT

Site Observations: MB (10 m/s) 1740 (12/057) ✓†

Dual Doppler Times: 1725 - 1736, UND/TDWR
1823 - 1833, UND/TDWR
1844 - 2012 UND/TDWR

RHI Scans: MIT
1824 - 1831, N
2011 - 2025, SSW
2106 - 2135, SSE/S/SSW/SW
UND
1928 - 1930, SSW

ASR-WSP data: None

Sounding Times: 1203, 1459, 1757, 2045

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: Yes, but it has not been processed

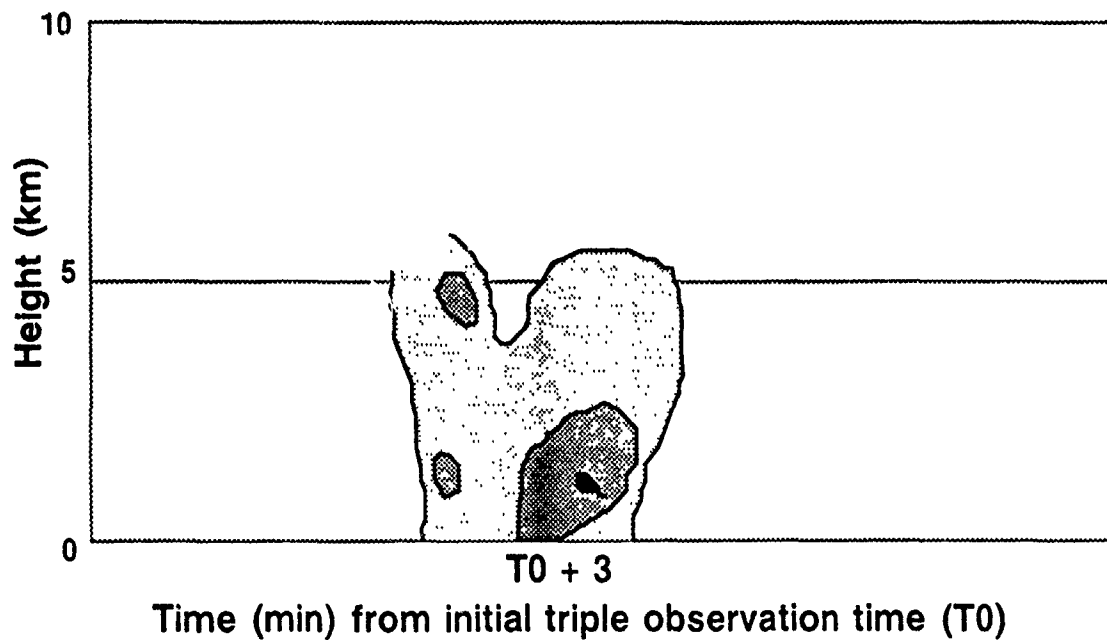
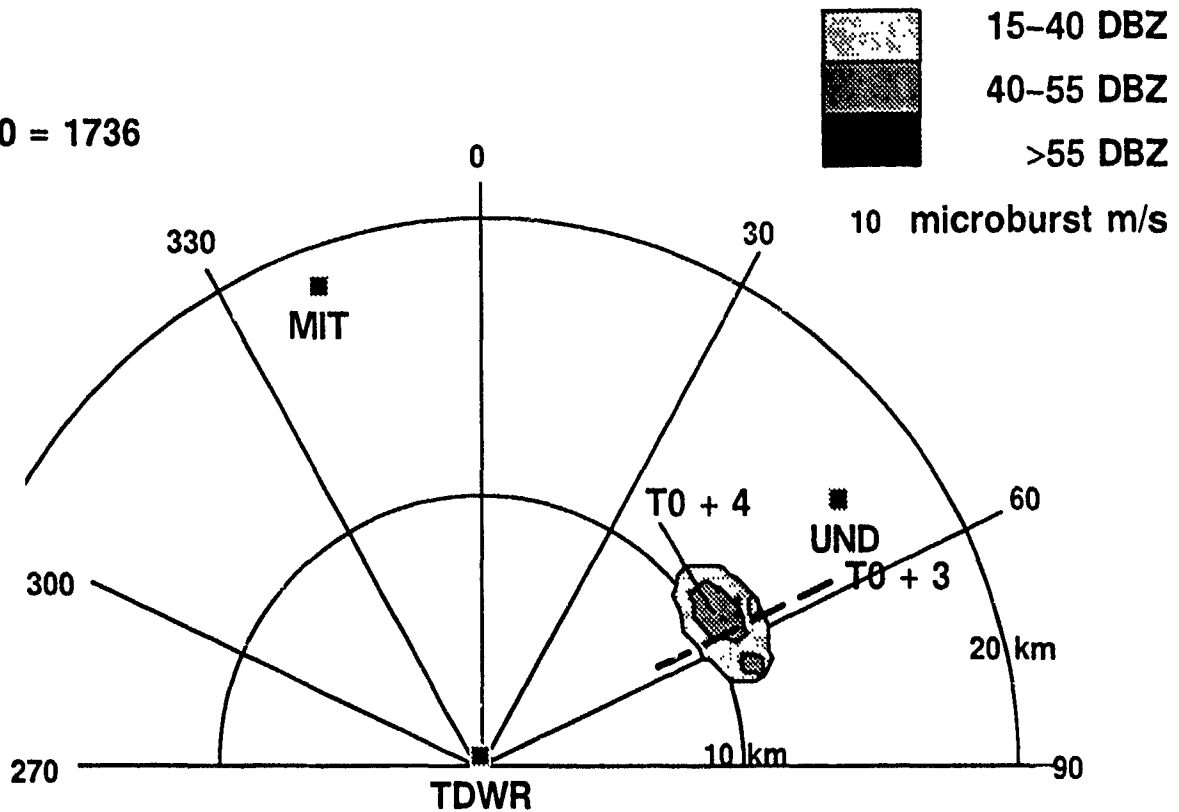
AWCS data: Yes

Interferometer data: Yes; 1814 (9/20) – 2237 (9/21)

Corona point data: None

21 SEPTEMBER 91

T0 = 1736



22 SEPTEMBER 91

Description: Numerous showers and thunderstorms moved rapidly from the NE to the SW across the triple Doppler region. One group of showers and thunderstorms produced a 12 m/s outflow while traversing the triple region. The sounding taken at 1451 GMT showed light to moderate east-northeasterly winds below the freezing level (4.9 km), and moderate northerly winds above. The surface temperature was 25.9°C, the dew point was 22.3°C, and the lifted condensation level was 0.3 km.

The accompanying sketch shows the group of showers and thunderstorms as it passes through the triple Doppler region and produces a microburst at $T_0 + 11$ min. The RHI shows the vertical extent of the system.

Triple Doppler Times: 1705 - 1750 MIT/UND/TDWR

Total Coverage Times: 1440 - 2101, TDWR
1647 - 1750, UND
1525 - 2214, MIT

Site Observations: MB (12 m/s) 1716 (08/347) ✓†
GF (6 m/s) 1719 (12/356)

Dual Doppler Times: None outside of triple times

RHI Scans: MIT
1525 - 1530, E/SE
1531 - 1533, NE
1533 - 1540, SE
1541 - 1616, NE
1616 - 1617, NW
1626 - 1628, S/W,
1630 - 1703, NE/E/ESE
1831 - 1918, N/NE
1927 - 2018, NW/W
2220 - 2227, N/E
2027 - 2039, W
2041 - 2214 N/NE

ASR-WSP data: None

Sounding Times: 1210, 1451

Aircraft data: None

ACARS data: Yes

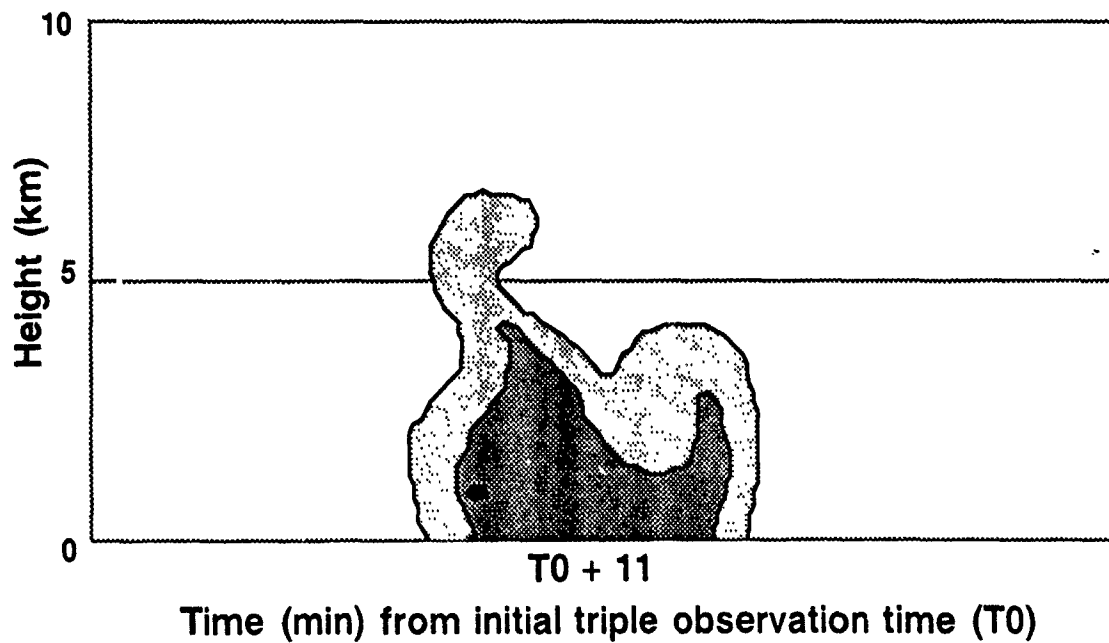
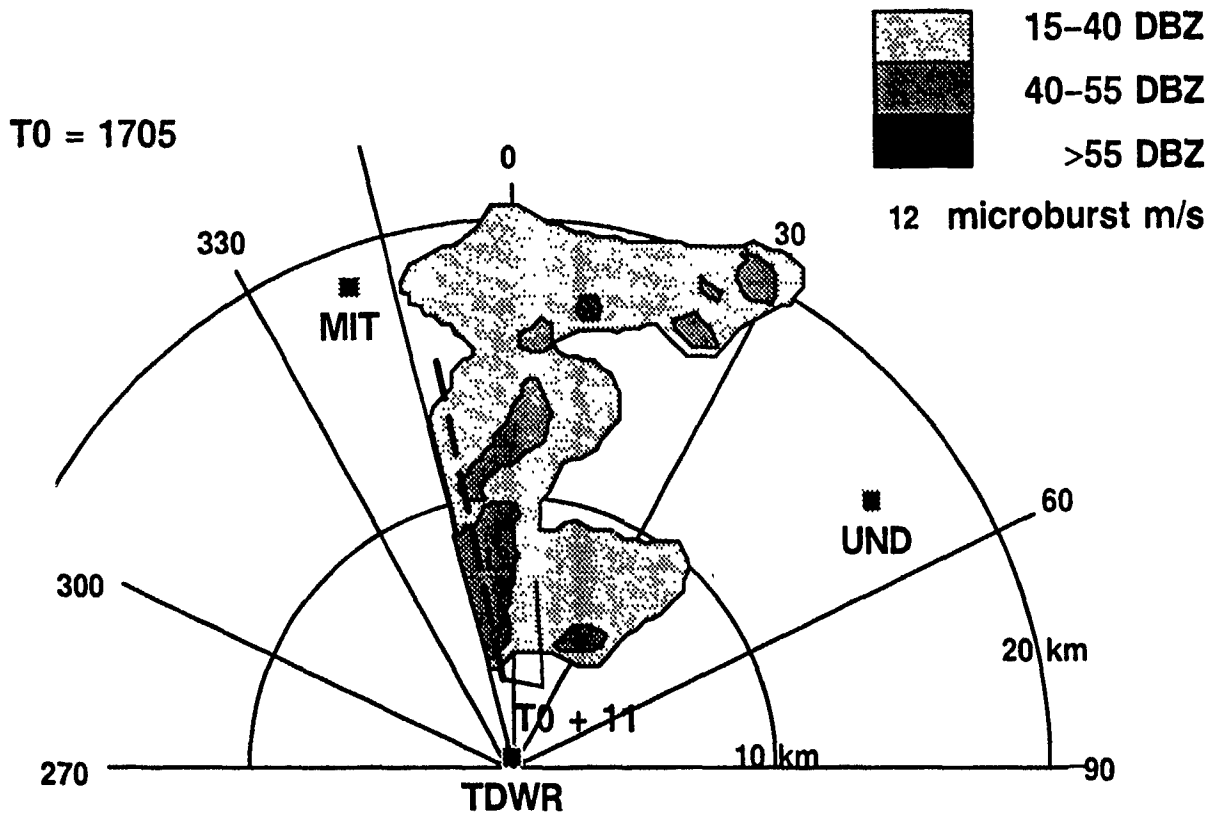
Mesonet data: Yes, but it has not been processed

AWOS data: Yes

Interferometer data: Yes; 0400 – 2127

Corona point data: 1705 – 1750
Stations C25, C32, C33

22 SEPTEMBER 91



25 SEPTEMBER 91

Description: Many showers and thunderstorms moved in rapidly from the W, forming a loosely connected, disorganized line as it moved into the triple Doppler region. The line extended far to the N and to the S of the triple region. More development took place within the triple region, but it eventually dissipated, forming an extended region of stratiform precipitation. Thunderstorms embedded within the line produced three moderate microbursts, two beginning outside the triple Doppler region. The sounding taken at 1748 GMT showed moderate to strong southwesterly winds from the surface to 12 km. The surface temperature was 30.3°C, the dew point was 19.7°C, the freezing level was 4.8 km, and the lifted condensation level was 0.9 km. The sounding taken at 2020 GMT showed moderate to strong southwesterly winds from the surface to 12 km. The surface temperature was 25.8°C, the dew point was 19.6°C, the freezing level was 4.6 km, and the lifted condensation level was 0.5 km.

The accompanying sketch shows the line moving into the triple Doppler region from the west. The higher reflectivity regions drawn are part of the same line. Only the 40 dBZ contours are drawn, since the 15 dBZ contours would make the sketch confusing. The RHIs also have only the 40 dBZ contour for the same reason.

Triple Doppler Times: 1638 - 1844 MIT/UND/TDWR

Total Coverage Times: 1554 - 0041, TDWR
1632 - 1844, UND
1540 - 0111, MIT

Site Observations: GF (6 m/s) 1735, MCO
MB (18 m/s) 1735 (6/315)
MB (16 m/s) 1742 (13/344)
MB (18 m/s) 1755 (6/326) ✓†

Dual Doppler Times: 1632 - 1638 UND/TDWR

RHI Scans: MIT
1540 - 1636, W
1848 - 1939, NE/S
1941 - 2002, W/NW
2006 - 2015, NE/E/ESE
2206 - 2332, W/NW
2337 - 2344, W
2347, NNE
2348 - 0111, W/NW/N

ASR-WSP data: 1229 - 1809

Sounding Times: 1210, 1504, 1748, 2020

Aircraft data: None

ACARS data: Yes

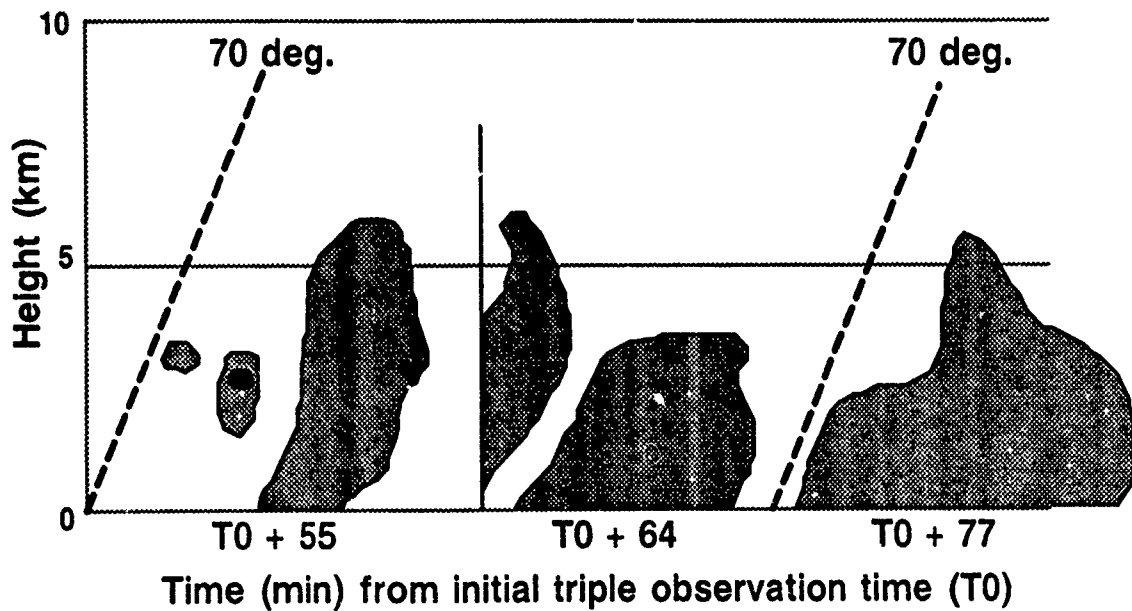
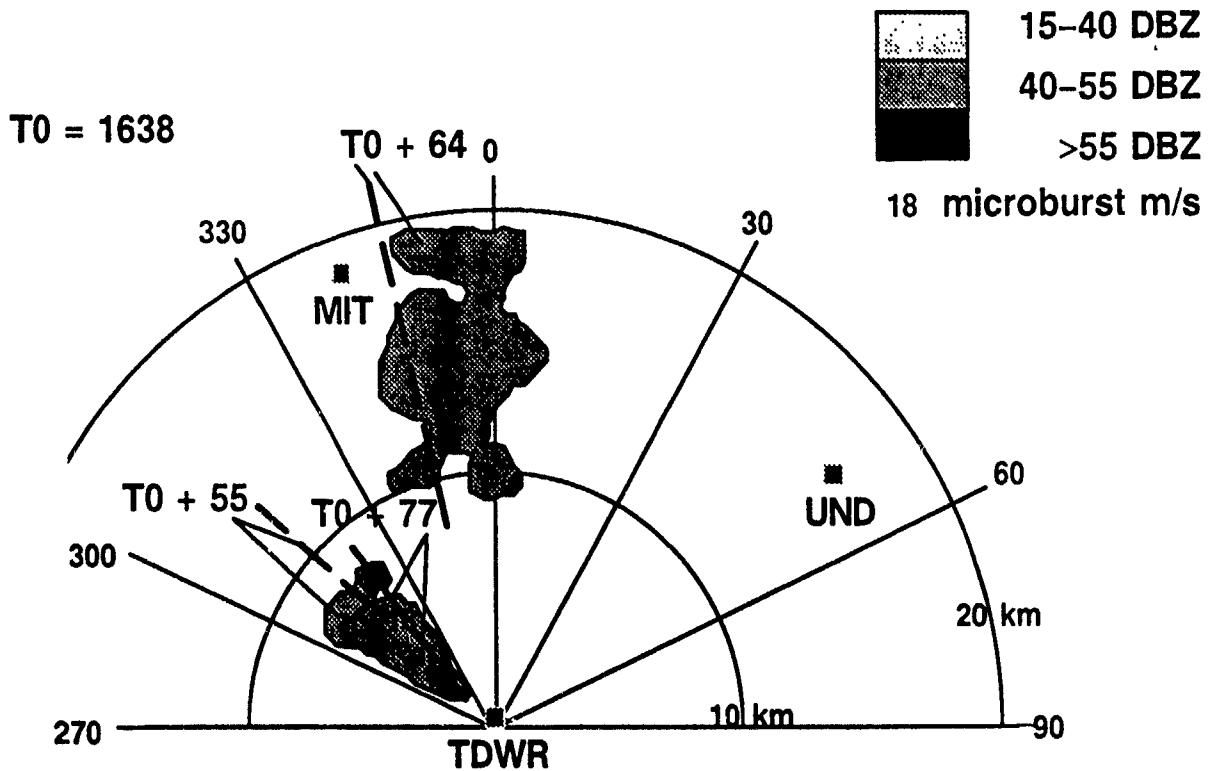
Mesonet data: Yes, but it has not been processed

AWOS data: Yes

Interferometer data: Yes; 0014 - 0000

Corona point data: None

25 SEPTEMBER 91



29 SEPTEMBER 91

Description: A large area of showers and thunderstorms oriented in a broad N-S line moved from E to W across the triple Doppler region. Most of the activity dissipated as it crossed the triple region, and new development took place on the northern edge of the area of precipitation. The entire line moved rapidly to the W, leaving the triple region clear. There was no sounding for this day.

The accompanying sketch shows the large area of showers and thunderstorms moving westward across the triple Doppler region. The area is shown at the time of maximum outflow of the only recorded microburst of the day in the triple region, at $T_0 + 43$ min. An RHI through the cell that produced the outflow is shown at the same time. The area of precipitation is shown exiting the region at $T_0 + 72$ min.

Triple Doppler Times: 1532 - 1651 MIT/UND/TDWR

Total Coverage Times: 1845 - 2112, TDWR
1525 - 1730, UND
1524 - 2038, MIT

Site Observations: GF (6 m/s) 1559 (06/074), MCO
MB (12 m/s) 1615 (09/038), MCO ✓†

Dual Doppler Times: 1525 - 1532, UND/TDWR
1651 - 1717 UND/TDWR

RHI Scans: MIT
1524 - 1530, NE
1703 - 1730 SW/W/NW
1738 NE
1738 - 1828 W/WNW
1852 - 2038 SE/E
TDWR
2105 S
2112 S

ASR-WSP data: None

Sounding Times: None

Aircraft data: None

ACARS data: Yes

Mesonet and LLWAS data: Yes, but it has not been processed

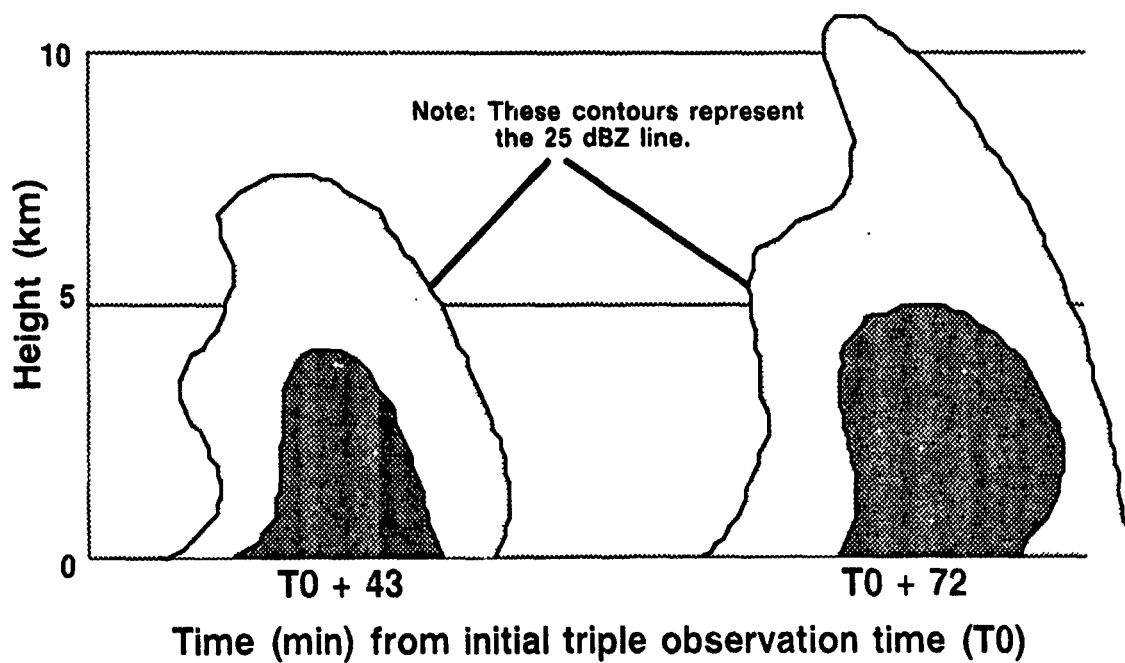
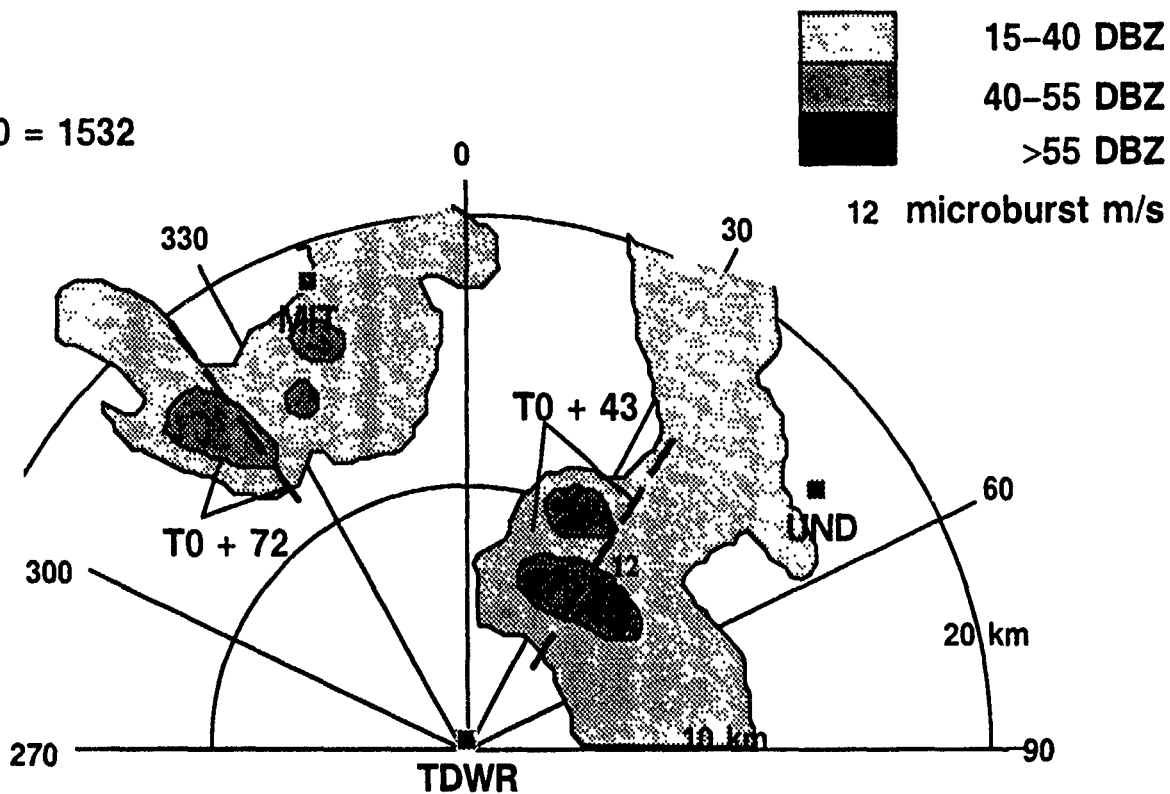
AWOS data: Yes

Interferometer data: Yes; 1038 (9/29) – 1024 (9/30)

Corona point data: 1532 – 1651
Stations C25, C32, C33, C28

29 SEPTEMBER 91

T0 = 1532



4. SUMMARY

Statistics and detailed information on thunderstorms scanned with coordinated triple Doppler radars have been summarized in this report. The availability of radar and supporting sensor data has been detailed for each triple Doppler case. All of the data described herein are available through Lincoln Laboratory, under sponsorship of the Federal Aviation Administration. Written requests for specific data may be directed to:

Dr. Marilyn M. Wolfson
MIT Lincoln Laboratory
P.O. Box 73
Lexington, MA 02173.

APPENDIX A
CORONA POINT STATION - SENSOR ASSOCIATION

Since different corona point sensors could be physically located on the same corona point station (*e.g.*, when a malfunctioning sensor had to be replaced), Table A-1 lists each corona point station, its associated sensors, and the dates of the associations. One corona point sensor may be associated with several corona point stations over the course of the summer.

Table A-1. Association between corona point stations (locations shown in Fig. 6) and the individual corona point sensors, by date.

CORONA PT STATION #	CORONA PT SENSOR	DATES
Station 1	# 115	6/18 - 10/4
Station 3	# 111	6/18 - 10/4
Station 6	# 114	6/18 - 10/4
Station 7	# 109	6/18 - 10/4
Station 14	# 107	6/18 - 7/25
	# 2	7/26 - 7/28
	# 103	7/29 - 8/3
	# 104	8/13 - 8/23
	# 5	8/24 - 10/4
Station 20	# 2	6/18 - 7/7
Station 22	# 112	7/4 - 10/4
Station 24	# 106	6/18 - 7/14
	# 104	6/15 - 7/25
	# 106	7/26 - 8/3
	# 103	8/4 - 10/4
Station 25	# 101	6/18 - 10/4
Station 28	# 106	8/13 - 10/4
Station 32	# 5	6/28 - 8/23
	# 104	8/24 - 10/4
Station 33	# 3	6/28 - 7/14
	# 4	7/15 - 7/25
	# 1	7/26 - 8/3
	# 105	8/4 - 10/4
Station 35	# 113	7/7 - 10/4
Station 39	# 108	7/7 - 10/4
ASR	# 110	8/29 - 10/4

LIST OF ABBREVIATIONS

ACARS	Aircraft Communications Addressing and Reporting Service
AGL	Above Ground Level
ARINC	Aeronautical Radio, Incorporated
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
AWOS	Automated Weather Observing System
CaPE	Convective and Precipitation/Electrification Experiment
FAA	Federal Aviation Administration
FSL	Forecast Systems Laboratory
GF	Gust Front
GMT	Greenwich Mean Time
INS	Inertial Navigation System
ITWS	Integrated Terminal Weather System
LLWAS	Low Level Wind Shear Alert System
LORAN	Long Range Navigation system
MB	Microburst
MCO	Orlando International Airport
MIT	Massachusetts Institute of Technology
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Science
NOAA	National Oceanic and Atmospheric Administration
ONERA	Office National d'Etudes et de Recherches Aerospatiales
RHI	Range-Height Indicator
SAFIR	Système d'Alerte Foudre par Interferometrie Radioelectrique
TASS	Terminal Area Surveillance System
TDWR	Terminal Doppler Weather Radar
UND	University of North Dakota
VHF	Very High Frequency
WSP	Wind Shear Processor

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